

According to new syllabus



# MDCAT PHYSICS

## PREPARATION & PRACTICE BOOK

SELF STUDY GUIDE

TO SECURE  
**100%**  
SUCCESS

*Written By:*

**AZHAR IQBAL**

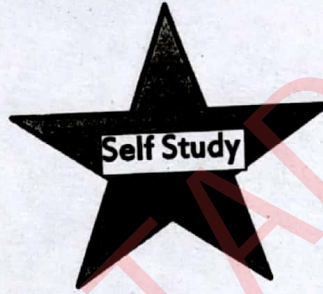
### *Salient Features*

- Conceptual Approach
- Shortcuts & Tricks for Easy Solution
- Explanation of Topics In Urdu  
For Ease of Students
- High-yield Practice Questions with Key

# Entry Test Preparation & Practice Book

*A solution to*

## MDCAT PHYSICS



### Features

- Easy and Concise material
- Short Tricks to solve MCQs
- Urdu Explanation is added for easy understanding
- Key and explanation of MCQs are included

**Written by**

**Prof. AZHAR IQBAL**

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**NMDCAT PREP BOOK**

**By AZHAR IQBAL 0336-7098894**

## **PREFACE**

I, PROF. AZHAR IQBAL, am teaching Physics to the students of MDCAT and F.Sc from the last 12 years. Since long, I have been observing the problems of Students of MDCAT, as well as feeling that for the preparation of MDCAT, there are no such books in the market that can solve the problems of the students. Therefore, in order to solve the problems of the students of MDCAT, I decided to write comprehensive book.

Now, by the grace of Allah, The Almighty, I have successfully written a book for the student of MDCAT. The book contains two portions i.e. MDCAT preparation book and MDCAT practice book. This book is a combination multiple extraordinary qualities that have never been observed in any other book.

- All the topics have been written in quite an easy way.
- The book has been written according to prescribed syllabus of MDCAT
- Difficult questions have solved by using short tricks
- A chapter consisting of short tricks have also been added in the book
- Difficult concepts have also been described in Urdu for the convenience and better comprehension of the students.

I hope this book will be quite helpful in solving the problems of the students of MDCAT. It will lead them to the target learning as well.

I am looking forward for your valuable suggestions and feedback. So that I will make improvements in this effort in my next edition.

Best wishes

**Author**

Prof. AZHAR IQBAL

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**NMDCAT PREP BOOK**

**By AZHAR IQBAL 0336-7098894**

## DEDICATION

To  
My Beloved Wife,  
For her continued unfailing Love, Support and  
Understanding that made the completion of  
this book possible.

## (Preparation Book)

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(Practice Book)

**CONTENTS**

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**PREPARATION BOOK**

## UNIT 00 &gt;&gt;

## BASIC TRICKS

## Important Tips to Solve Physics MCQ's

1. فزکس کے زیادہ تر MCQ's کا تعلق Formulas کے ساتھ ہوتا ہے اس لئے جب بھی آپ کوئی Topic پڑھیں تو اس میں استعمال ہونے والے Formulas کو اچھی طرح یاد کریں اور Formulas سے بننے والے مندرجہ ذیل قسم کے سوالات کو ضرور مد نظر رکھیں۔

1. ایک Quantity کے بڑھنے یا کم ہونے سے کسی دوسری Quantity کی value پر کیا اثر ہوگا۔

**Example:**

By increasing the distance from the positive point charge its potential:

- (a) Increases (b) Decreases ✓  
(c) remain same (d) either increases or decreases

**Solution:**

$$\text{As } V = \frac{Kq}{r} \text{ or } V \propto \frac{1}{r}$$

By increasing distance V decreases.

2. ایک Quantity کی values میں Ratio دی کی ہو تو دوسری Quantity کی values میں کیا Ratio ہوگی۔

**Example:**

Two bodies having equal mass are moving with velocities  $10 \text{ ms}^{-1}$  and  $20 \text{ ms}^{-1}$  then the ratio between their K.E is  
(a) 1 : 2 (b) 2 : 1 (c) 1 : 4 ✓ (d) 4 : 1

**Solution:**

$$\text{As } K.E = \frac{1}{2}mv^2 \text{ or } K.E \propto v^2$$

The ratio between velocity is 1 : 2 so ratio in K.E is 1 : 4

3. اگر کسی ایک Quantity کو Double یا Half وغیرہ کر دیا جائے تو دوسری Quantity پر کیا اثر ہوگا۔

**Example:**

If length of pendulum is doubled then its time period will become

- (a) Double (b) Half (c)  $\sqrt{2}$  times ✓ (d)  $\frac{1}{\sqrt{2}}$  times

$$\text{Solution: As } T = 2\pi\sqrt{\frac{l}{g}} \text{ or}$$

$T \propto \sqrt{l}$  If length is doubled T becomes  $\sqrt{2}$  times.

## (Two-Two Values Relationship)

4. اگر ایک Quantity کی دو ویلیوز اور دوسری Quantity کی ایک value دی گئی ہو تو اس کی دوسری ویلیوز کیا ہوگی۔

**Example:**

If at pressure 10 atm the volume of the gas is  $2 \text{ m}^3$ . At what pressure the volume of the gas will be  $5 \text{ m}^3$ .

- (a) 5 atm (b) 4 atm ✓ (c) 3 atm (d) 2 atm

**Solution:**

$$\frac{P_2}{P_1} = \frac{V_1}{V_2} \Rightarrow P_2 = \frac{P_1 V_1}{V_2} = \frac{10 \times 2}{5} = 4 \text{ atm}$$

5. ایک Quantity باقی Quantities independent یا dependent ہے۔

Example:

Speed of sound in air is independent of :

- (a) density of air (b) pressure of air ✓  
(c) Temperature of air (d) None of these

Solution:

$$\text{As } v = \sqrt{\frac{\gamma P}{\rho}} \text{ and } \rho \propto P$$

(Numerical Type Question)

6. Numerical Type Question کو solve کرنے کے لیے question میں دیکھیں کہ کونسی Quantities دی گئی ہیں اور کس کے بارے میں پوچھا گیا ہے اور ان کا آپس میں Relation کیا ہے۔

Example: If a body of a mass 2kg is moving with momentum 6Ns then its K.E will be:

- (a) 6 J (b) 9 J ✓ (c) 12 J (d) 15 J

Solution: As  $K.E = \frac{p^2}{2m} = \frac{6^2}{2 \times 2}$   
 $= \frac{36}{4} = 9J$

(Re-arranging Formulas)

7. کسی بھی فارمولے کو Re-arrange کر کے یا Variables نام بدل کر پوچھا جاسکتا ہے۔

Example:

If T is time period of simple pendulum at a place where acceleration due to gravity is g then length of pendulum is:

- (a)  $\frac{gT^2}{4\pi^2}$  ✓ (b)  $\frac{gT}{4\pi^2}$  (c)  $\frac{4\pi^2}{gT^2}$  (d)  $\frac{4\pi}{gT^2}$

Solution:

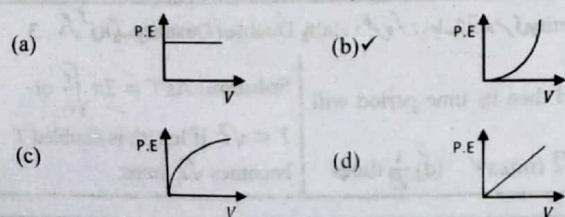
$$\text{As } T = 2\pi \sqrt{\frac{l}{g}}$$

$$l = \frac{gT^2}{4\pi^2}$$

(Graphical Types Question)

8. Quantities میں گراف کیسا ہوگا۔ گراف کی slope کیا بتائے گی۔ گراف کے Area کیا بتائے گا۔

Example 1: The graph between potential energy stored in a capacitor versus voltage across the capacitor is:



Solution 1:

$$\text{As } P.E = \frac{1}{2} CV^2$$

$$P.E \propto V^2$$

So the graph between P.E and Voltage is a parabola.

Solution 2:

$$\text{Slope} = v/t = a$$

Solution 3:

$$\text{area} = Fd = W$$

Example 2: The slope of velocity time graph represent the:

- (a) displacement (b) acceleration ✓ (c) momentum (d) force

Example 3: Area under force displacement graph represent the:

- (a) acceleration of the body (b) Work done on the body ✓  
(c) Power of the body (d) Impulse on the body

## 2. Important Relations Between Quantities

Relation	If value of x increases then y	If value of x doubled then y	If values of x are in ratio 2:3 then ratio in y is	Two-Two values relation
$y \propto x$ Example: $Q = CV$ $\Rightarrow Q \propto V$	Increases	Doubled جتنا x میں change آئے گا۔ Y بھی اتنے change ہوگا۔	2 : 3 جو x میں ratio ہوگی وہی y میں بھی ہوگی	$\frac{y_2}{y_1} = \frac{x_2}{x_1}$
$y \propto x^2$ Example: $K.E = \frac{1}{2}mv^2$ $\Rightarrow K.E \propto v^2$	Increases	Four times x کی values square کرنے سے y میں change کا پتا چلے گا۔	x کی values square کرنے سے y میں ratio چلے گی	$\frac{y_2}{y_1} = \frac{x_2^2}{x_1^2}$
$y \propto \sqrt{x}$ Example: $T = 2\pi \sqrt{\frac{l}{g}}$ $\Rightarrow T \propto \sqrt{l}$	Increases	$\sqrt{2}$ times x کی values $\sqrt{\quad}$ کرنے سے y میں change کا پتا چلے گا۔	$\sqrt{2} : \sqrt{3}$ x کی values $\sqrt{\quad}$ کرنے سے y میں ratio چلے گی	$\frac{y_2}{y_1} = \frac{\sqrt{x_2}}{\sqrt{x_1}}$
$y \propto \frac{1}{x}$ Example: $PV = \text{Const.}$ $\Rightarrow P \propto \frac{1}{V}$	Decreases	Halved جتنا x میں change آئے گا۔ Y میں اتنے change ہوگا۔	3 : 2 جو x میں ratio ہوگی وہی y میں اس سے الٹی ratio ہوگی	$\frac{y_2}{y_1} = \frac{x_1}{x_2}$
$y \propto \frac{1}{x^2}$ Example: $E = \frac{kq}{r^2}$ $\Rightarrow E \propto \frac{1}{r^2}$	Decreases	$\frac{1}{4}$ times x کی values square کرنے کے الٹا کرنے سے y میں change کا پتا چلے گا۔	9 : 4 x کی values square کرنے کے الٹا کرنے سے y میں ratio چلے گی	$\frac{y_2}{y_1} = \frac{x_1^2}{x_2^2}$
$y \propto \frac{1}{\sqrt{x}}$ Example: $f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$ $\Rightarrow f \propto \frac{1}{\sqrt{m}}$	Decreases	$\frac{1}{\sqrt{2}}$ times x کی values $\sqrt{\quad}$ کرنے کے الٹا کرنے سے y میں change کا پتا چلے گا۔	$\sqrt{3} : \sqrt{2}$ x کی values $\sqrt{\quad}$ کرنے کے الٹا کرنے سے y میں ratio چلے گی	$\frac{y_2}{y_1} = \frac{\sqrt{x_1}}{\sqrt{x_2}}$

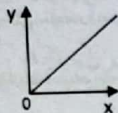
نوٹ: کوئی بھی quantities میں Proportionality relation لگانے کیلئے باقی quantities constant ہونا ضروری ہے۔

## 3. How to Determine Graph?

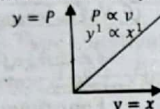
اگر  $x$  اور  $y$  دونوں کی پاورز Relation میں one ہو تو گراف Straight line ہو گا اور origin سے پاس کرے گا۔

(i)  $y^1 \propto x^1$

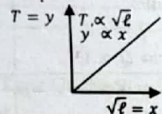
Graph:



Example 1: Graph b/w momentum and velocity



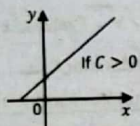
Example 2: Graph b/w time period and square root of length



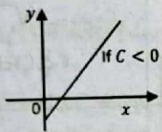
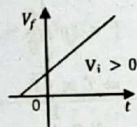
(ii)  $y^1 = mx^1 + c$

اگر  $x$  اور  $y$  دونوں کی پاورز one ہو لیکن کوئی constant add بھی ہو رہا ہو تو گراف origin سے پاس نہیں کرے گا۔

Graph:



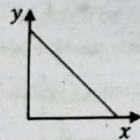
Graph:

Example 2:  $v_f^1 = v_i^1 + at^1$ 

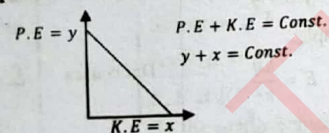
(iii)  $x^1 + y^1 = \text{Constant}$

اگر  $x$  اور  $y$  دونوں کی پاورز one ہو لیکن ان کا sum constant ہو تو گراف Straight line ہو گا

Graph:



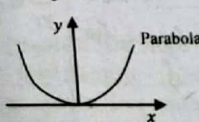
Example 2:



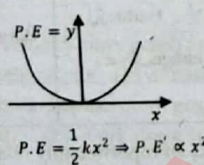
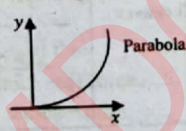
(iv)  $y^1 \propto x^2$

اگر ایک variable کی پاور one اور دوسرے کی پاور two ہو تو گراف Parabola ہو گا۔

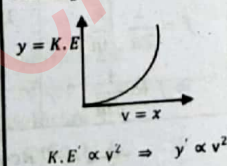
Graph:



Example:

For 1<sup>st</sup> Quadrant

Example:

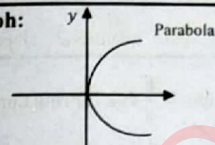
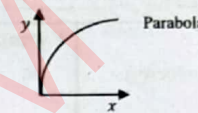


نوٹ: جس variable کی پاور کم ہوگی گراف اسی کی طرف bend ہو گا۔

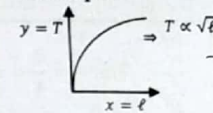
(v)  $y \propto \sqrt{x}$

اگر ایک variable کی پاور one اور دوسرے پر  $\sqrt{\quad}$  ہو تو گراف Parabola ہو گا۔

Graph:

For 1<sup>st</sup> Quadrant

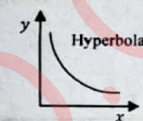
Example:



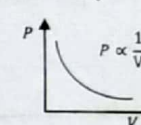
(vi)  $y \propto \frac{1}{x}$

اگر دونوں variables ایک دوسرے کے Inversely Proportional ہوں تو گراف Hyperbola ہو گا۔

Graph:



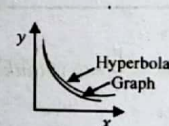
Example : For Boyle's Law



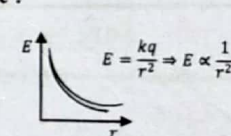
(vii)  $y \propto \frac{1}{x^2}$

اگر ایک variable دوسرے کے Square کے Inversely Proportional ہوں تو گراف Hyperbola سے زیادہ Steeper ہو گا۔

Graph:



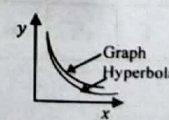
Example :



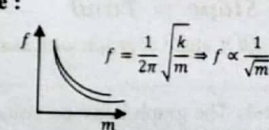
(viii)  $y \propto \frac{1}{\sqrt{x}}$

اگر ایک variable دوسرے کے  $\sqrt{\quad}$  کے Inversely Proportional ہوں تو گراف Hyperbola سے کم Steeper ہو گا۔

Graph:



Example :

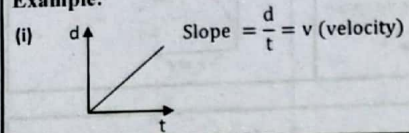


## 4. Slope of the Graph:

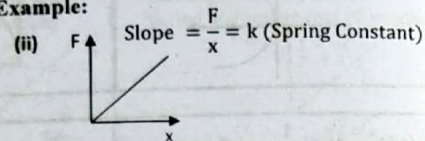
$$\text{Slope} = \frac{y}{x}$$

گراف کی slope کسی quantity کو represent کرتی ہے پتہ لگانے کے لیے y والی quantity کو x-axis والی quantity سے divide کریں۔

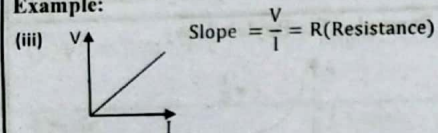
Example:



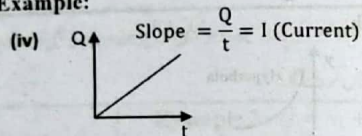
Example:



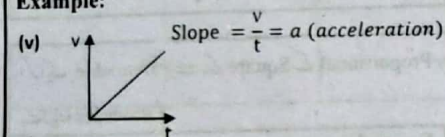
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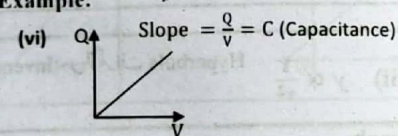
Example:



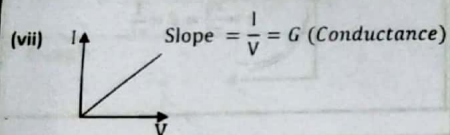
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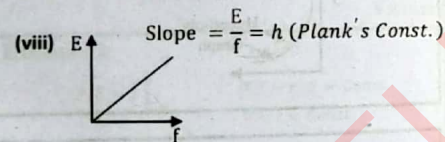
Example:



Example:



Example:

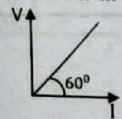


## 5. How to Find the Slope?

(i).  $\text{Slope} = \tan \theta$

( $\theta$  is angle of graph with x-axis)

Example-1: The graph between voltage and current in SI unit is shown in figure below then resistance will be:



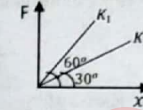
- (a)  $1/\sqrt{3}$  (b)  $\sqrt{3}$  ✓ (c) 1 (d) 0.5

Solution:

$$R = \frac{V}{I} = \text{slope} \\ = \tan 60^\circ = \sqrt{3}$$

$\theta$	$0^\circ$	$30^\circ$	$45^\circ$	$60^\circ$	$90^\circ$
$\tan \theta$	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	$\infty$

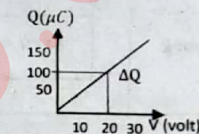
Example-2: The graph between force and extension for two spring is shown in figure below then find the ratio between the spring constant.



- (a) 1 : 3 (b) 3 : 1 ✓ (c) 1 : 1 (d) 9 : 1

(ii).  $\text{Slope} = \frac{\Delta y}{\Delta x}$

Example: The graph between charge and voltage for capacitor is shown in figure below. The capacitance of capacitor will be:



- (a)  $5\mu F$  ✓ (b)  $2.5\mu F$  (c)  $15\mu F$  (d)  $10\mu F$

Solution: As

$$K = \frac{F}{x} = \text{slope} = \tan \theta$$

$$\frac{K_1}{K_2} = \frac{\tan 60^\circ}{\tan 30^\circ} \\ = \frac{\sqrt{3}}{1/\sqrt{3}} = \frac{3}{1}$$

Solution:

$$C = \frac{\Delta y}{\Delta x} \\ = \frac{\Delta Q}{\Delta V} = \frac{100\mu C}{20V} \\ = 5\mu F$$

## DIFFERENT CASES FOR SLOPE


## 6. Area Under the Graph:

گراف کا Area کسی quantity کو represent کرتا ہے۔ پتہ لگانے کیلئے x-axis اور y-axis کی quantities کو multiply کر کے دیکھیں کہ کوئی quantity کا فارمولا جیتا ہے۔

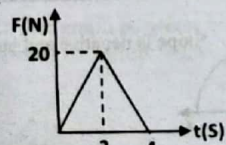
<b>Example:</b> 	<b>Example:</b> 	<b>Example:</b> 
<b>Example:</b> 	<b>Example:</b> 	<b>Example:</b> 

**Note:** Greater the area under the graph, larger the quantity.

## 7. How to find the area under the graph.

<b>Rectangle</b> 	<b>Triangle</b> 
<b>Trapezium</b> 	<b>Circle</b> 

**Example:** The variation of force acting on a body with time is shown. What is the change in momentum of body after 4 s?



- (a) 10 Ns (b) 20 Ns (c) 40 Ns ✓ (d) 80 Ns

**Solution:**

$$\begin{aligned}
 \text{Change in momentum} &= \text{impulse} \\
 &= \text{Area of triangle} \\
 &= \frac{1}{2} \times \text{base} \times \text{height} \\
 &= \frac{1}{2} \times 4 \times 20 = 40 \text{ Ns}
 \end{aligned}$$

## 8. Percentage Type Questions:

1<sup>st</sup> Type:

If percentage change in X is less than 10% then percentage change in Y is given as:  
 $\% \text{ change in } Y = \text{Power of } X (\% \text{ change in } X)$

**Example:**

If length of pendulum is increased by 6% then its time period will be increased by:

- (a) 6% (b)  $\sqrt{6}\%$  (c) 3% ✓ (d) 1.5%

**Solution:** As  $T = 2\pi \sqrt{\frac{\ell}{g}} \Rightarrow T \propto \sqrt{\ell}$

$$\% \text{ change in } T = \frac{1}{2} (\% \text{ change in } \ell) = 3\%$$

2<sup>nd</sup> Type Suppose X and Y are related as  $Y \propto X^2$ 

If percentage change in X is greater than 10% then percentage change in Y is given as:

(i). When X increases:

$$\% \text{ change in } Y = 2(\% \text{ change in } X) + \left(\frac{\% \text{ change in } X}{10}\right)^2$$

**Example:**

If momentum of a body increases by 20% then its K.E will be increased by:

- (a) 20% (b) 40% (c) 44% ✓ (d) 400%

**Solution:** As  $K.E = \frac{p^2}{2m} \Rightarrow K.E \propto p^2$

$$\% \text{ change in K.E} = 2(20\%) + \left(\frac{20\%}{10}\right)^2 = 44\%$$

(ii). When X decreases:

$$\% \text{ change in } Y = 2(\% \text{ change in } X) - \left(\frac{\% \text{ change in } X}{10}\right)^2$$

**Example:**

If momentum of a body decreases by 10% then its K.E will be decreased by:

- (a) 9% (b) 5% (c) 10% (d) 19% ✓

**Solution:** As  $K.E = \frac{p^2}{2m} \Rightarrow K.E \propto p^2$

$$\% \text{ change in K.E} = 2(10\%) - \left(\frac{10\%}{10}\right)^2 = 44\%$$

3<sup>rd</sup> Type: If change in X is multiple of 100%.

**Example:**

If length of the pendulum is increased by 100% then its time period will become:

- (a) Double (b) Half (c)  $\frac{1}{\sqrt{2}}$  times (d)  $\sqrt{2}$  times ✓

**Solution:** As  $T = 2\pi \sqrt{\frac{\ell}{g}} \Rightarrow T \propto \sqrt{\ell}$

If length increases by 100% its mean it is doubled. Then time period will become  $\sqrt{2}$  times.

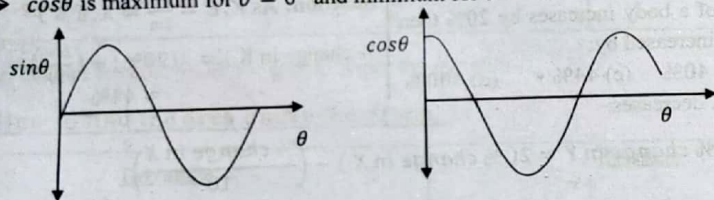
% Change	100 %	200 %	300 %	400 %
Quantity becomes	Doubled	Three times	Four times	Five times

## 9. Trigonometric Ratios.

$\theta$	$0^\circ$	$30^\circ$	$45^\circ$	$60^\circ$	$90^\circ$
$\sin\theta$	0 0%	$\frac{1}{2} = 0.5 = 50\%$	$\frac{1}{\sqrt{2}} = 0.7 = 70\%$	$\frac{\sqrt{3}}{2} = 0.86$ $= 86\%$	1 100%
$\cos\theta$	1% 100%	$\frac{\sqrt{3}}{2} = 0.86 = 86\%$	$\frac{1}{\sqrt{2}} = 0.7 = 70\%$	$\frac{1}{2} = 0.5$ $= 50\%$	0 0%

Notice from the above table:

- Value of  $\sin\theta$  increases by increasing angle and vice versa.
- Value of  $\cos\theta$  decreases by increasing angle and vice versa.
- $\sin\theta$  is maximum for  $\theta = 90^\circ$  and minimum for  $\theta = 0^\circ$ .
- $\cos\theta$  is maximum for  $\theta = 0^\circ$  and minimum for  $\theta = 90^\circ$ .



## PREFIXES

Prefix	Decimal	Multiplier	Prefix	Decimal	Multiplier
Yotta	$10^{24}$	Y	Deci	$10^{-1}$	d
Zetta	$10^{21}$	Z	Centi	$10^{-2}$	c
Exa	$10^{18}$	E	Milli	$10^{-3}$	m
Peta	$10^{15}$	P	Micro	$10^{-6}$	$\mu$
Tera	$10^{12}$	T	Nano	$10^{-9}$	n
Giga	$10^9$	G	Pico	$10^{-12}$	p
Mega	$10^6$	M	Femto	$10^{-15}$	f
Kilo	$10^3$	k	Atto	$10^{-18}$	a
Hecto	$10^2$	h	Zepto	$10^{-21}$	z
Deca	$10^1$	da	Yocto	$10^{-24}$	y

## SI BASE QUANTITIES AND BASE UNITS

Base quantity		SI Base Unit	
Name	Symbol	Name	Symbol
Length	L	Meter	m
Mass	m	Kilogram	kg
Time, duration	t	Second	s
Electric current	I	Ampere	A
Thermodynamic temperature	T	Kelvin	K
Amount of substance	n	Mole	mol
Luminous intensity	$I_v$	Candela	cd

SOME IMPORTANT CGS UNIT  
AND THEIR RELATION WITH SI UNIT

Quantity	CGS units	Equivalent in SI units
Length	cm (centimeter)	$10^{-2}m$
Mass	g (gram)	$10^{-3}kg$
Time	s (second)	s
Force	dyn (dyne)	$10^{-5}N$
Energy	erg	$10^{-7}J$
Charge	(Franklin) Fr	$3.34 \times 10^{-10}C$
Current	Bi (biot)	10A
Heat energy	Cal (calorie)	4.18 J
Magnetic flux density	G (gauss)	$10^{-4}T$
Magnetic flux	Mx (Maxwell)	$10^{-8}Wb$

**Physics Quantities Having No units**

Following physical quantities have no units  
Strain, dielectric constant, refractive index, specific gravity, magnification, relative permeability etc.

**Note**

Physical quantities which are to be added or subtracted must have same units.

**Physical Quantities Having Same Units**

Quantities	Units	Dimensions
Energy, Work and Heat	Joule = 1J = $\text{kgm}^2\text{s}^{-2}$	$\text{ML}^2\text{T}^{-2}$
Impulse and Momentum	Ns = $\text{kgms}^{-1}$	$\text{MLT}^{-1}$
Electric Field intensity and Potential gradient	$\frac{N}{C} = \text{kgms}^{-3}\text{A}^{-1}$	$\text{MLT}^{-3}\text{A}^{-1}$
Plank's constant and Angular momentum	J.s = $\text{kgms}^2\text{s}^{-1}$	$\text{ML}^2\text{T}^{-1}$
Pressure, Stress, Modulus of elasticity and Energy density	$\frac{N}{m^2} = \text{kgm}^{-1}\text{s}^{-2}$	$\text{ML}^{-1}\text{T}^{-2}$
General gas constant and Molar specific heat	$\text{Jmol}^{-1}\text{K}^{-1} = \text{kgm}^2\text{s}^{-2}\cdot\text{mol}^{-1}\text{K}^{-1}$	$\text{ML}^2\text{T}^{-2}\text{N}^{-1}\theta^{-1}$
Surface tension and spring constant	$\frac{N}{m} = \text{kg s}^{-2}$	$\text{MT}^{-2}$
Entropy, Heat capacity and Boltzman constant	$\frac{J}{K} = \text{kgm}^2\text{s}^{-2}\text{K}^{-1}$	$\text{ML}^2\text{T}^{-2}\theta^{-1}$
Resistance, Reactance of capacitor, reactance of inductor and impedance	$\frac{V}{A} = \text{Jc}^{-1}\text{A}^{-1} = \text{kgm}^2\text{s}^{-3}\text{A}^{-2}$	$\text{ML}^2\text{T}^{-3}\text{A}^{-2}$

**SOME IMPORTANT DERIVED QUANTITIES AND THEIR UNITS.**

QUANTITY	SI UNIT	IN-TERMS OF BASE UNITS
Velocity	$\text{ms}^{-1}$	$\text{ms}^{-1}$
Acceleration	$\text{ms}^{-2}$	$\text{ms}^{-2}$
Area	$\text{m}^2$	$\text{m}^2$
Volume	$\text{m}^3$	$\text{m}^3$
Density	$\text{kgm}^{-3}$	$\text{kgm}^{-3}$
Force	N	$\text{kgms}^{-2}$

QUANTITY	SI UNIT	IN-TERMS OF BASE UNITS
Work, Energy	J	$\text{kgm}^2\text{s}^{-2}$
Power	W	$\text{Js}^{-1} = \text{kgm}^2\text{s}^{-3}$
Pressure, Stress	Pa	$\text{Nm}^{-2} = \text{kgm}^{-1}\text{s}^{-2}$
Torque	Nm	$\text{kgm}^2\text{s}^{-2}$
Modulus of elasticity	$\text{Nm}^{-2}$	$\text{kgm}^{-1}\text{s}^{-2}$
Angular momentum	J.s	$\text{kgm}^2\text{s}^{-1}$
Impulse, Momentum	N.s	$\text{kgms}^{-1}$
Surface tension	$\text{Nm}^{-1}$	$\text{kg s}^{-2}$
Boltzman constant	$\text{Jk}^{-1}$	$\text{kgm}^2\text{s}^{-2}\text{K}^{-1}$
Gravitational constant	$\text{Nm}^2\text{kg}^{-2}$	$\text{kg}^{-1}\text{m}^3\text{s}^{-2}$
Charge	C	A.s
Electric potential	$V = \text{JC}^{-1}$	$\text{kgm}^2\text{s}^{-3}\text{A}^{-1}$
Resistance	$\text{ohm} = \text{VA}^{-1}$	$\text{kgm}^2\text{s}^{-3}\text{A}^{-2}$
Capacitance	$F = \text{CV}^{-1}$	$\text{kg}^{-1}\text{m}^{-2}\text{s}^4\text{A}^2$
Inductance	$\text{VsA}^{-1} = \text{H}$	$\text{kgm}^2\text{s}^{-2}\text{A}^{-2}$
Electric flux	$\text{Nm}^2\text{C}^{-1}$	$\text{kgm}^3\text{s}^{-3}\text{A}^{-1}$
Magnetic flux	$\text{Wb} = \text{NmA}^{-1} = \text{T}\cdot\text{m}^2$	$\text{kgm}^2\text{s}^{-2}\text{A}^{-1}$
Magnetic induction	$\text{T} = \text{Wbm}^{-2} = \text{Nm}^{-1}\text{A}^{-1}$	$\text{kg s}^{-2}\text{A}^{-1}$
Permittivity	$\text{C}^2\text{N}^{-1}\text{m}^{-2}$	$\text{kg}^{-1}\text{m}^{-3}\text{s}^4\text{A}^2$
Permeability	$\text{Wbm}^{-1}\text{A}^{-1}$	$\text{kgms}^{-2}\text{A}^{-2}$
Entropy	$\text{JK}^{-1}$	$\text{kgm}^2\text{s}^{-2}\text{K}^{-1}$
General gas constant	$\text{Jmol}^{-1}\text{K}^{-1}$	$\text{kgm}^2\text{s}^{-2}\text{mol}^{-1}\text{K}^{-1}$
Electric field intensity	$\text{NC}^{-1}$	$\text{kgms}^{-3}\text{A}^{-1}$
Plank's constant	J.s	$\text{kgm}^2\text{s}^{-1}$

## SOME IMPORTANT PHYSICAL QUANTITIES

Quantities	Symbol	Value
Time period of geostationary satellite	$T$	24 hour
Minimum height of geostationary satellite	$h$	36000 km
Radius of geostationary satellite	$r$	42400 km
Speed of sound ( $0^\circ\text{C}$ )	$v$	$332\text{ ms}^{-1}$
Avogadro's number	$N_0$	$6.02 \times 10^{23}$ particles
Boltzman constant	$K$	$1.38 \times 10^{-23}\text{ Jk}^{-1}$
General gas constant	$R$	$8.314\text{ Jkg}^{-1}\text{mol}^{-1}$
Specific heat of water	$C$	$4186\text{ Jkg}^{-1}\text{K}^{-1}$
Permittivity of free space	$\epsilon_0$	$8.85 \times 10^{-12}\text{ C}^2\text{N}^{-1}\text{m}^{-2}$
Charge on electron	$-e$	$-1.6 \times 10^{-19}\text{ C}$
Charge of proton	$+e$	$+1.6 \times 10^{-19}\text{ C}$
Charge on alpha particle	$+2e$	$3.2 \times 10^{-19}\text{ C}$
Columb constant for free space	$K$	$9 \times 10^9\text{ Nm}^2\text{C}^{-2}$
Permeability of free space	$\mu_0$	$4\pi \times 10^{-7}\text{ Wbm}^{-1}\text{A}^{-1}$
Potential barrier for Si	$V$	0.7V
Potential barrier for Ge	$V$	0.3V
Speed of light in free space	$c$	$3 \times 10^8\text{ ms}^{-1}$
Rest mass of photon	$m_0$	Zero
Charge of photon	$q$	Zero
Plank constant	$h$	$6.63 \times 10^{-34}\text{ Js}$
Compton's wavelength	$\lambda_c$	$2.43 \times 10^{-12}\text{ m}^{-1}$
Radius of 1 <sup>st</sup> orbit of hydrogen atom	$r_1$	0.053 nm
Velocity of electron in 1 <sup>st</sup> orbit of hydrogen	$V_1$	$2.19 \times 10^6\text{ ms}^{-1}$
Ground state energy of hydrogen	$E_0$	-13.6 eV
Angular momentum of first orbit of hydrogen	$L_1$	$1.05 \times 10^{-34}\text{ Js}$
Unified atomic mass unit	$1u$	$1.6606 \times 10^{-27}\text{ kg}$
Mass of electron	$m_e$	$9.1 \times 10^{-31}\text{ kg} = 0.000554$
Mass of proton	$m_p$	$1.673 \times 10^{-27}\text{ kg} = 1.007274$
Mass of neutron	$m_n$	$1.675 \times 10^{-27}\text{ kg} = 1.0086650$
e/m of electron		$1.75 \times 10^{11}\text{ Ckg}^{-1}$
e/m of proton		$9.6 \times 10^7\text{ Ckg}^{-1}$
e/m of neutron		Zero
m/e of neutron		Infinite

## UNIT 01 &gt;&gt;

## FORCE AND MOTION

**Mechanics:**

Study of motion of objects is called mechanics. It is divided into two types.

(i) Kinematics (ii) Dynamics

i. **Kinematics:** Study of motion of objects without referring the force.

ii. **Dynamics:** Study of motion of objects taking into consideration of force (the cause of motion)

**Distance:**

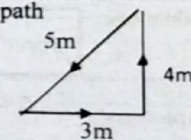
Total length of path followed by body is called distance.

- It is scalar quantity. its SI unit is meter.
- It may be zero or positive but never negative.
- Distance of a body in motion can never be zero.

**Example:** (i) For one vibration distance =  $4A$   
(ii) For one revolution distance =  $2\pi r$

**Example:**

Consider an object moves in a closed path



Total distance =  $3+4+5=12\text{m}$

**Displacement:**

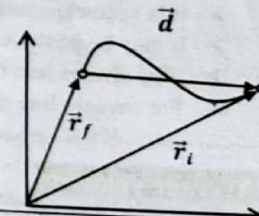
Change in position of a body from its initial position to final position is called displacement.

- It is vector quantity and its direction is from initial to final position.
- Its SI unit is meter

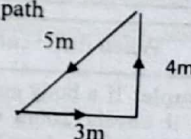
$$\vec{d} = \vec{r}_f - \vec{r}_i$$

(Displacement = Final position vector - Initial position vector)

- It may be positive, negative or zero.
- It is shortest distance between initial and final position.
- Displacement is always less than or equal to distance.
- If a body moves in straight line its displacement and distance are equal.

**Example:**

Consider an object moves in a closed path



Total displacement = 0

**Example:** (i) For one vibration, displacement = 0  
(ii) For one revolution, displacement = 0

اگر کوئی ہادی اپنی ابتدائی position پر واپس آجائے تو اس کا Displacement صفر ہوگی

**Example:**

Find magnitude of displacement, if a body moves from point P(2, 3) to a point Q(5, 7).

- (a) 4m (b) 5m (c) 7m (d) 17m

**Solution:**

$$\vec{d} = \vec{r}_f - \vec{r}_i = (5\hat{i} + 7\hat{j}) - (2\hat{i} + 3\hat{j}) = 3\hat{i} + 4\hat{j}$$

$$|\vec{d}| = \sqrt{(3)^2 + (4)^2} = 5\text{m}$$

**Speed:**

Distance covered by a body in one second is called speed.

- It is scalar quantity and its SI unit is  $\text{ms}^{-1}$ .
- It is always positive.
- Speed of a moving object cannot be zero or negative.
- The ratio of speed to magnitude of velocity of an object is always greater than one.

$$\text{Speed} = \frac{\text{total distance}}{\text{time}}$$

**Example:**

Consider an object moves in a closed path of radius 2m with time period 3.14 sec. then its speed is

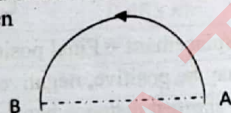
- (a)  $2\text{ms}^{-1}$  (b)  $4\text{ms}^{-1}$  (c)  $4\pi\text{ms}^{-1}$  (d) zero

**Solution:**

$$\text{Speed} = \frac{\text{Total distance}}{\text{Time}} = \frac{2\pi r}{T} = \frac{2 \times 3.14 \times 2}{3.14} = 4\text{ms}^{-1}$$

**Example:**

Consider an object move from one end to other end of diameter of a circle of radius 1m in 5sec then



$$\vec{v}_{av} = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{2r}{t} = \frac{2 \times 1}{5} = 0.4 \text{ ms}^{-1}$$

**Average velocity:**

$$\vec{v}_{av} = \frac{\text{Total displacement}}{\text{Total time}}$$

i. When different displacements and time are given:  $v_{av} = \frac{d_1 + d_2}{t_1 + t_2}$

**Example:** If a body covers 100m displacement in 4sec and then it covers 200m displacement in 6sec. The average velocity of the body will be:

- (a)  $10\text{ms}^{-1}$  (b)  $20\text{ms}^{-1}$  (c)  $30\text{ms}^{-1}$  ✓ (d)  $40\text{ms}^{-1}$

$$\text{Solution: } v_{av} = \frac{d_1 + d_2}{t_1 + t_2} = \frac{100 + 200}{4 + 6} = \frac{300}{10} = 30\text{ms}^{-1}$$

ii. When different velocities and time are given:  $v_{av} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$  (put  $d = v t$ )

**Example:** If a body is moving with velocity  $60\text{ms}^{-1}$  for 1<sup>st</sup> hour and  $30\text{ms}^{-1}$  for next two hours. Then its average velocity of the body will be:

- (a)  $30\text{kmh}^{-1}$  ✓ (b)  $60\text{kmh}^{-1}$  (c)  $90\text{kmh}^{-1}$  (d)  $120\text{kmh}^{-1}$

$$\text{Solution: } v_{av} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2} = \frac{(60)(1) + (30)(2)}{1 + 2} = 30\text{kmh}^{-1}$$

iii. If velocities are given and time internals are equal ( $t_1 = t_2$ ):  $v_{av} = \frac{v_1 + v_2}{2}$

**Example:** If a car is moving a velocity  $20\text{ms}^{-1}$  for 1<sup>st</sup> half hour and with velocity  $30\text{ms}^{-1}$  for next half hour. Then its average velocity of the body will be:

- (a)  $12.5\text{ms}^{-1}$  (b)  $25\text{ms}^{-1}$  ✓ (c)  $50\text{ms}^{-1}$  (d)  $60\text{ms}^{-1}$

$$\text{Solution: } v_{av} = \frac{v_1 + v_2}{2} = \frac{20 + 30}{2} = \frac{50}{2} = 25\text{ms}^{-1}$$

iv. When different velocities and displacements are given:  $v_{av} = \frac{(d_1 + d_2)v_1 v_2}{d_1 v_2 + d_2 v_1}$  ( $t = \frac{d}{v}$ )

**Example:** If a velocity of a body is  $2\text{ms}^{-1}$  for 100m displacement and  $4\text{ms}^{-1}$  for next 400m displacement. Then average velocity of the body will be:

- (a)  $3\text{ms}^{-1}$  (b)  $3.3\text{ms}^{-1}$  ✓ (c)  $6\text{ms}^{-1}$  (d)  $6.3\text{ms}^{-1}$

$$\text{Solution: } v_{av} = \frac{(d_1 + d_2)v_1 v_2}{d_1 v_2 + d_2 v_1} = \frac{(100 + 400) \times 2 \times 4}{(100 \times 4) + (400 \times 2)} = \frac{4000}{1200} = 3.3\text{ms}^{-1}$$

v. If displacement are equal ( $d_1 = d_2$ ).  $v_{av} = \frac{2v_1 v_2}{v_1 + v_2}$

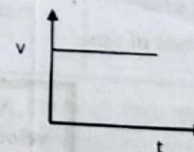
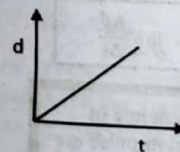
**Example:** If body covers first half displacement with velocity  $10\text{ms}^{-1}$  and next half displacement with velocity  $20\text{ms}^{-1}$ . Then its average velocity of the body will be:

- (a)  $13.3\text{ms}^{-1}$  ✓ (b)  $15\text{ms}^{-1}$  (c)  $20.5\text{ms}^{-1}$  (d)  $0\text{ms}^{-1}$

$$\text{Solution: } v_{av} = \frac{2v_1 v_2}{v_1 + v_2} = \frac{2 \times 10 \times 20}{10 + 20} = \frac{400}{30} = 13.3\text{ms}^{-1}$$

**Uniform Velocity:**

If body covers equal displacements in equal intervals of time then it is moving with uniform velocity.



If body is moving with uniform velocity then instantaneous and average velocity are equal.

**Instantaneous Velocity:**

Velocity of body at any particular instant of time is called instantaneous velocity. OR limiting value of  $\frac{\Delta d}{\Delta t}$  as time interval  $\Delta t$  approaches to zero.

$$\vec{v}_{ins} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{d}}{\Delta t}$$

Acceleration کا مطلب ہے ہر سیکنڈ میں ہڈی کی ولا سٹی کتنی بڑھے گی یا کم ہوگی

**Acceleration:**

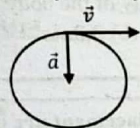
Rate of change of velocity of a body is called acceleration.

**Average Acceleration:**

$$\vec{a}_{av} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{t}$$

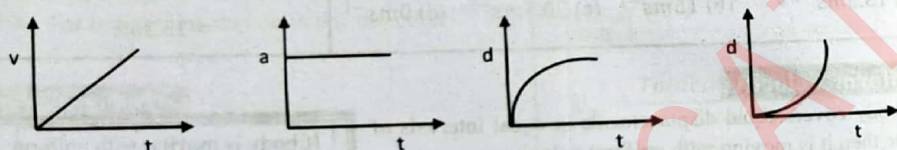
- It is vector quantity and its SI unit  $ms^{-2}$ .
- Its direction is always along the direction of force.
- It may or may not be in the direction of velocity.
- Acceleration is positive and parallel to velocity when velocity of body increases.
- Acceleration is negative and anti-parallel to velocity when velocity of body decreases.
- Acceleration is zero when velocity of the body is constant.
- Acceleration is perpendicular to velocity when speed of the body is constant and only its direction is changing.

Example: Centripetal acceleration is perpendicular to velocity.

**Uniform Acceleration:**

Body is moving with uniform acceleration when its velocity changes equally in equal intervals of time.

Some important graph for uniform acceleration are shown in figure below

**Instantaneous Acceleration:**

Acceleration of a body at any particular instant of time.

$$\vec{a}_{ins} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{v}}{\Delta t}$$

Acceleration is not zero when either magnitude or direction of velocity changes

Acceleration, change in velocity, force and impulse are always in same direction

By AZHAR IQBAL0336-7098894

**DISPLACEMENT-TIME GRAPH:**

- Graph which illustrates the variation in displacement with time.
- Its slope represents the velocity.

**Some Important Examples of Displacement-Time Graph**

Graph	Velocity	Slope	Acceleration
	Zero	Zero	Zero
	Constant	Constant	Zero
	Increasing	Increasing	Positive
	Decreasing	Decreasing	Negative
	First decreasing then increases	First decreasing then increases	Negative and constant
	Negative and constant	Negative and constant	Zero

Example: If the displacement time graph of two moving bodies are making angle  $30^\circ$  and  $60^\circ$  with time axis then the ratio between their velocities will be

- (a)  $1:\sqrt{3}$  (b)  $3:1$  (c)  $1:3$  (d)  $\sqrt{3}:1$

Solution:  $\frac{v_1}{v_2} = \frac{\tan 30^\circ}{\tan 60^\circ}$   
 $= \frac{1/\sqrt{3}}{\sqrt{3}} = 1:3$

## VELOCITY-TIME GRAPH

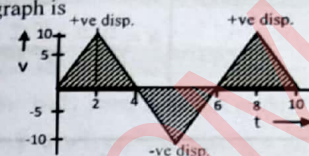
- Graph which illustrates the variation in velocity of the body with time.
- Slope of  $v-t$  graph = acceleration.
- Area under  $v-t$  graph = distance covered.

## Some Important Examples of Velocity-Time Graph

Graph	Velocity	Slope	Acceleration
	Constant ( $v_i = v$ )	Zero	Zero
	Increasing	Positive and constant	Positive and constant
	Increasing ( $v_i = 0$ )	Positive and increasing	Positive and increasing
	Increasing ( $v_i = 0$ )	Positive and decreasing	Positive and decreasing
	First decreasing then increases in opposite direction ( $v_i \neq 0$ )	Negative and constant	Negative and constant
	Increasing ( $v_i \neq 0$ )	Positive and constant	Positive and constant

## Example 1:

The total distance and displacement covered from the following  $v-t$  graph is

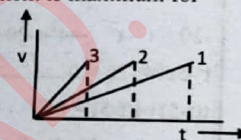


- (a) 50m, 50m  
(c) 30m, 50m

- (b) 50m, 30m  
(d) 50m, zero

## Example 2:

If  $v-t$  graph for a body is shown in the figure below displacement is maximum for

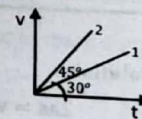


- (a) 1  
(c) 3

- (b) 2  
(d) same for all

## Example 3:

If  $v-t$  graph for two bodies is shown in the figure below then the ratio between their accelerations will be



- (a) 1:1

- (b)  $1:\sqrt{3}$

- (c) 3:1

- (d)  $\sqrt{3}:1$

## Equations of Motion

## 1st Equation:

$$v_f = v_i + at$$

(جب distance نہ دیا گیا ہو تو باقی کسی quantity کو معلوم کرنے کے لیے Equation استعمال کریں)

## Solution:

$$\begin{aligned} \text{distance} &= \text{total area of triangles} \\ &= \frac{1}{2}(4)(10) + \frac{1}{2}(2)(10) \\ &\quad + \frac{1}{2}(4)(10) = 50 \end{aligned}$$

(Distance is always positive)

$$\begin{aligned} \text{displacement} &= \frac{1}{2}(4)(10) - \\ &\quad \frac{1}{2}(2)(10) + \frac{1}{2}(4)(10) = 30 \end{aligned}$$

## Solution:

$$S_1 > S_2 > S_3$$

(جس گراف کے نیچے زیادہ ہوگا اس

کا Displacement بھی زیادہ ہوگا)

$$a_3 > a_2 > a_1$$

(جس گراف کی slope زیادہ ہوگی اس میں

acceleration بھی زیادہ ہوگا)

## Solution:

$$\begin{aligned} \frac{a_1}{a_2} &= \frac{\tan 30^\circ}{\tan 45^\circ} \\ &= \frac{\left(\frac{1}{\sqrt{3}}\right)}{(1)} = \frac{1}{\sqrt{3}} \end{aligned}$$

**Example:**

If a car accelerates uniformly from rest to a velocity  $10\text{ms}^{-1}$  in 50 sec. Then the acceleration of the car is

- (a)  $5\text{ms}^{-1}$  (b)  $0.2\text{ms}^{-2}$   
(c)  $0.2\text{ms}^{-1}$  (d)  $-0.2\text{ms}^{-2}$

**Solution:**

$$v_f = v_i + at$$

$$a = \frac{v_f - v_i}{t} = \frac{10 - 0}{50} = 0.2\text{ms}^{-2}$$

**2nd Equation:**

$$S = v_i t + \frac{1}{2} at^2$$

(جب "final velocity" نہ دی گئی ہو تو باقی کسی

quantity کو معلوم کرنے کے لیے 2<sup>nd</sup> Equation استعمال کریں)

**Example:**

A ball is thrown vertically upward from a 100m high tower with velocity  $5\text{ms}^{-1}$ . The time taken by the ball to reach the ground will be

- (a) 4s (b) 5s  
(c) 8s (d) 10s

جو دیکٹر initial velocity کے opposite ہوئے ان کے ساتھ لکھیں گے۔

$$\text{Solution: } S = v_i t + \frac{1}{2} at^2$$

$$-100 = 5t + \frac{1}{2}(-10)t^2$$

$$-20 = t - t^2 \rightarrow t^2 - t - 20 = 0$$

$$t^2 - 5t + 4t - 20 = 0$$

$$t(t-5) + 4(t-5) = 0$$

$$t-5 = 0 \text{ and } t+4 = 0$$

$$t = 5\text{sec}$$

**3rd Equation:**

$$2as = v_f^2 - v_i^2$$

(جب "time" نہ دیا گیا ہو تو باقی کسی quantity کو معلوم کرنے کے

لے 3<sup>rd</sup> Equation استعمال کریں)

**Solution:**

$$2as = v_f^2 - v_i^2$$

$$2a \times 25 = (0)^2 - (10)^2$$

$$a = -0.5\text{ms}^{-2}$$

**Example:**

If a car moving with velocity  $10\text{ms}^{-1}$  is brought to rest in 25m distance then acceleration of the car will be

- (a)  $5\text{ms}^{-2}$  (b)  $0.5\text{ms}^{-2}$   
(c)  $0.2\text{ms}^{-2}$  (d)  $-0.5\text{ms}^{-2}$

- **Note:** - These equations are only applicable for linear motion with uniform acceleration.
- **Note:** - Quantities opposite to initial velocity are taken negative. For example when body is thrown upward then acceleration due to gravity is taken negative.

**MOTION UNDER THE ACTION OF GRAVITY****(i) When body falls downward:**

- When body starts from rest or falls freely or dropped or is released then  $v_i = 0$ .
- When body is thrown  $v_i \neq 0$ .
- $a = g = 9.8\text{m/s}^2 \approx 10\text{m/s}^2$

$$g = 10\text{ms}^{-2}$$

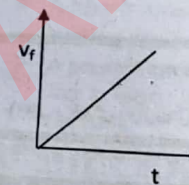
(مطلب ہر سیکنڈ میں پڑی کی ولاسٹی 10 m/s بڑھے گی)

**Relation between final velocity and time**

$$v_f = v_i + gt$$

$$v_f = gt \quad (v_i = 0)$$

$$v_f \propto t$$

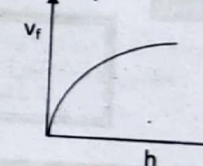
**Relation between final velocity and height**

$$v_f^2 - v_i^2 = 2gS$$

$$v_f = \sqrt{2gS} \quad (v_i = 0)$$

$$v_f = \sqrt{2gh} \quad (S = h)$$

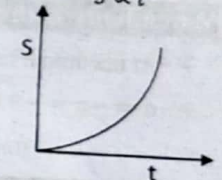
$$v_f \propto \sqrt{h}$$

**Relation between height and time**

$$S = v_i t + \frac{1}{2} gt^2$$

$$S = \frac{1}{2} gt^2 \quad (v_i = 0)$$

$$S \propto t^2$$



- Time to reach the ground:  $t = \sqrt{\frac{2s}{g}}$

$$t = \sqrt{\frac{2h}{g}}$$

$$\text{OR } t \propto \sqrt{h}$$

**Example:**

If a ball falling freely from a height "h" reaches the ground in 10 seconds then the time taken by the ball falling freely from height "2h" will be

- (a) 5 sec (b) 7 sec  
(c) 14 sec (d) 20sec

**Solution:**

since  $t \propto \sqrt{h}$

when height becomes two time then time will become  $\sqrt{2}$  times

$$t = \sqrt{2} \times 10 = 14\text{sec}$$

Distance covered in time  $t$ :

$$S = \frac{1}{2}gt^2$$

OR

$$S \approx 5t^2$$

**Example**

The distance covered by a freely falling body in three second is

- (a) 5m (b) 15m  
(c) 20m (d) 45m

**Solution:**  $S \approx 5t^2 = 5 \times 9 = 45m$

Distance covered in  $n$ th second:

$$S_{nth} = 10n - 5$$

**Example**

The distance covered by a freely falling body in 3<sup>rd</sup> second is

- (a) 5m (b) 15m  
(c) 20m (d) 45m

**Solution:**  $S = 10n - 5$   
 $= 10 \times 3 - 5 = 20m$

**Note:**

If air friction is ignored then motion is independent of mass of the body. For example if two bodies of mass 2kg and 4 kg are dropped from same height they will reach the ground in same time, with same velocity and same acceleration.

**When body is thrown upward:**

➤ At maximum height  $v_f = 0$ .

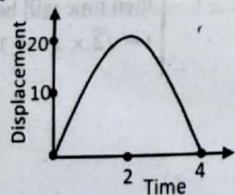
$$a = -g = -9.8 \frac{m}{s^2} \approx -10m/s^2$$

$$g = -10 ms^{-2}$$

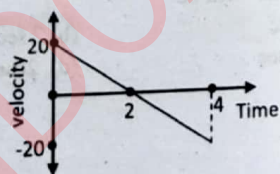
(مطلب ہر سیکنڈ میں ہڈی کی ولا سٹی  $10 ms^{-1}$  کم ہوتی جائے گی)

Time to reach maximum height:	Time of Flight	Maximum height attained
$v_f = v_i + at$	$S = v_i t - \frac{1}{2}gt^2$	$v_f^2 - v_i^2 = -2gh$
At max. height $v_f = 0$	For time of flight $S = 0$	At max. height $v_f = 0$
$t = \frac{v_i}{g}$	$t = \frac{2v_i}{g}$	$h = \frac{v_i^2}{2g}$

Displacement Time Graph



Velocity Time Graph

**NEWTON'S LAWS OF MOTION**

- Sir Isaac Newton published his three laws of motion in 1687 in his book 'principia'.
- Newton's laws are empirical laws.
- Newton's laws are not applicable for sub-atomic particles and motion with speed approaching to speed of light.

Nobody moves or comes to rest itself  
(Abu-Ali- Sena)

**1st Law of Motion:**

A body at rest will remain at rest and a body moving with uniform velocity, continue its motion unless acted upon by some unbalanced external force.

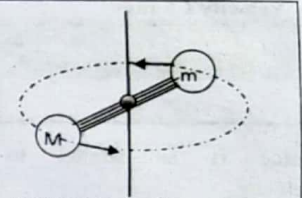
- It gives the qualitative definition of force.
- It is also known as law of inertia.

**Inertia:**

- Property of body tending to maintain its state of rest or uniform motion is called inertia.
- Mass of a body is quantitative measure of its inertia.

**Example:**

- A person standing in a bus falls backward due to inertia when bus suddenly starts moving.
- A person standing in a moving bus move forward due to inertia when brakes of the bus is applied suddenly.



A measurement of mass independent of gravity. When two masses are equal the rod will rotate without wobble about its center.

**Inertial Frame of reference:**

A frame of reference in which Newton's 1<sup>st</sup> law of motion valid.

- Non- accelerated frame ( $\vec{v} = \text{constant}$ ) is inertial frame.

**Example:** A car moving with uniform velocity.

If both magnitude and direction of velocity are not changing then frame of reference is 'Inertial'

In thrill machine rides at amusement parks there may be an acceleration of  $3g$  or more. Without head rest this large acceleration may cause serious neck injury due to inertial effects.

**Non-inertial Frame of reference:**

A frame of reference in which Newton's 1<sup>st</sup> law of motion not valid.

- Accelerated frame ( $\vec{v} \neq \text{constant}$ ) is non-inertial frame.

If either magnitude and direction of velocity are changing then frame of reference is 'Non-Inertial'

**2nd Law of Motion:**

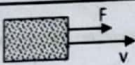

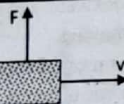
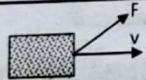
A force applied on a body produces an acceleration in its own direction. This acceleration is directly proportional to applied force and inversely proportional to mass of the body.

$$\vec{a} \propto \frac{\vec{F}}{m} \Rightarrow \vec{F} = m\vec{a}$$

- Gives the definition of mass.
- Direction of acceleration is always along the direction of force.

- No force is needed to continue the motion of the object
- Force is only needed to change the motion (velocity) of the object.

**Velocity Change**

Force is parallel to velocity		<ul style="list-style-type: none"> <li>• <math> \vec{v} </math> or speed increases.</li> <li>• Direction of velocity remains same.</li> </ul>
Force is anti-parallel to velocity		<ul style="list-style-type: none"> <li>• <math> \vec{v} </math> or speed decreases.</li> <li>• Direction of velocity remains same.</li> </ul>
Force is perpendicular to velocity		<ul style="list-style-type: none"> <li>• <math> \vec{v} </math> or speed remains constant.</li> <li>• Only direction of velocity change.</li> </ul>
Force acts at some angle with velocity		Both magnitude and direction of velocity changes.

**3rd Law of Motion:**

"Every action has equal and opposite reaction". ( $\vec{F} = -\vec{F}$ )

- Action and reaction always act on different bodies.
- According to 3<sup>rd</sup> law forces always exist in pairs.
- Action and reaction act on the line joining the two bodies.
- Action and reaction never balance each other.

**Example:** Swimming is an example of Newton's ..... law of motion

- (a) first (b) second (c) third ✓ (d) all of these

Throwing a package from a boat causes the boat to move backward (Newton's third law)

**MOMENTUM**

- The moving object possess a quality by virtue of which it exerts a force on anything that tries to stop it. Quality was called quantity of motion of the body by Newton. Now it is called linear momentum.
- Product of mass of body and its velocity is called momentum.

$$\vec{p} = m\vec{v}$$

- It is vector quantity and its direction is along the direction of velocity.
- Its SI unit  $\text{kgms}^{-1}$  or N.s

- If two bodies have same mass then  $p \propto v$ . The body moving faster will have larger momentum and vice versa.
- If two bodies are moving with same speed then  $p \propto m$  and heavier body will have larger momentum and vice versa.
- If two bodies are moving with same momentum then  $v \propto \frac{1}{m}$  and lighter body is moving faster and vice versa.

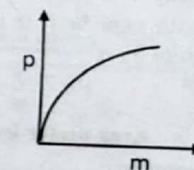
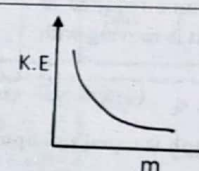
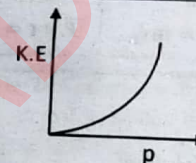
- K.E and momentum are related as

$$K.E = \frac{p^2}{2m}$$

or

$$p = \sqrt{2m(K.E)}$$

For same/constant mass	For same/constant momentum	For same/constant K.E
$K.E \propto p^2$	$K.E \propto \frac{1}{m}$	$p \propto \sqrt{m}$

**Newton's 2nd Law in terms of momentum**

"Time rate of change of momentum of a body" is equal to applied force.

$$\vec{F} = \frac{\Delta p}{\Delta t}$$

or

$$\vec{F} = \frac{m\vec{v}_f - m\vec{v}_i}{t}$$

- This is the most general form of Newton's 2<sup>nd</sup> law of motion.
- Force is directly proportional to change in momentum of the body.
- Force is inversely proportional to time of impact.

**Examples:**

- Helmet increases time of impact and reduces the force on the head to avoid serious injuring.
- Hair act like crumple zone, they increase the time of impact thus reduces the force. A force of 5N might be enough to fracture your naked skull (cranium) but with a covering of skin and hair a force of 50N would be needed.
- Air bags in cars increases the time of impact and thus reduces the force.

In knocking a bear down Lead bullet is more effective than rubber bullet of same momentum because time of impact for lead bullet is small and it will exert greater force

**Impulse:**

- Product of force and small interval of time ( $t$ ) is called impulse.
- $\text{Impulse} = \vec{F} \times t$
- It is vector quantity and its direction is along the direction of force.
- Its SI unit is  $\text{kgms}^{-1}$  or N.s.
- Impulse and momentum have same units.
- Impulse = change in momentum of the body:

$$\vec{F} \times t = m\vec{v}_f - m\vec{v}_i$$

Moving bodies may or may not have impulse

- If body is moving with uniform velocity it has no impulse.
- If body is moving with variable velocity its momentum changes and it will have impulse.

If body accelerates from rest  
 $v_i = 0$

$$\vec{F} \times t = m\vec{v}_f$$

If body brought to rest  
 $V_f = 0$

$$\vec{F} \times t = -m\vec{v}_i$$

**Example:**

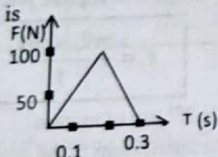
The force required to stop a body moving with a velocity  $v$  in a time  $t$  is 'F'. The force required to stop the same body in same time if it is moving with velocity  $2v$  is

- (a) F (b)  $2F$  ✓ (c)  $4F$  (d)  $F/2$

➤ Area under force-time graph is equal to impulse.

**Example:**

The graph between force and time for which force acts on the body is shown in the figure below. The change in the momentum of the body is



- (a) 15 N-sec ✓ (b) 150 N-sec (c) 300 N-sec (d) zero

**Solution:**

Since area under F-t graph is equal to impulse or change in momentum

$$\Delta p = \frac{1}{2} \times \text{base} \times \text{height}$$

$$\Delta p = \frac{1}{2} \times 0.3 \times 100$$

$$\Delta p = 15 \text{ N} \cdot \text{sec}$$

**LAW OF CONSERVATION OF MOMENTUM**

- If no external force acts on the system then system is called isolated system.

**Total linear momentum of an isolated system remains constant.**

$$\text{If } \vec{F}_{\text{ext}} = 0 \text{ then } \frac{\Delta \vec{p}}{\Delta t} = 0 \text{ or } \vec{p} = \text{constant}$$

(Both magnitude and direction of linear momentum are conserved)

- If masses  $m_1$  and  $m_2$  are moving with velocities  $\vec{v}_1$  and  $\vec{v}_2$  before the collision and with velocities  $\vec{v}_1'$  and  $\vec{v}_2'$  after the collision then

$$m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1' + m_2\vec{v}_2'$$

- When a fighter plane chasing another opens fire its speed and momentum decreases
- When pursued plane returns the fire its speed and momentum increases

**Special Case:**

If total initial momentum is zero. Then total final momentum is also zero.

**Example 1:** Spring is compressed between two masses  $p_i = 0$ , when spring is released then



- $\vec{p}_1 = -\vec{p}_2$   
(Both masses will have equal and opposite momentum)
- $p = mv \Rightarrow v \propto \frac{1}{m}$   
(Lighter body will move faster)
- $K.E = \frac{p^2}{2m} \Rightarrow K.E \propto \frac{1}{m}$   
(Lighter body will have greater K.E)

**Example 2:** Consider a bomb of mass 4kg initially at rest explodes into two pieces of masses 1kg and 3kg as shown in the figure below



- $\vec{p}_1 = -\vec{p}_2$  (Both masses will have equal and opposite momentum)

**Example:** what is ratio between the magnitude of their momentum

- (a) 1: -1 (b) 1: 3 (c) 3: 1 (d) 1: 1 ✓

- $p = mv \Rightarrow v \propto \frac{1}{m}$   
(Lighter body will move faster)

**Example:** what is ratio between the magnitude of their velocities

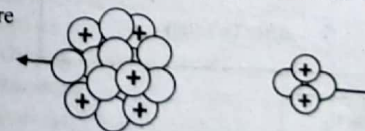
- (a) 1: -1 (b) 1: 3 (c) 3: 1 ✓ (d) 1: 1

- $K.E = \frac{p^2}{2m} \Rightarrow K.E \propto \frac{1}{m}$   
(Lighter body will have greater K.E)

**Example:** what is ratio between their kinetic energies?

- (a) 1: -1 (b) 1: 3 (c) 3: 1 ✓ (d) 1: 1

**Example 3:** Consider a nucleus at rest undergoes an alpha decay as shown in the figure



- $\vec{p}_1 = -\vec{p}_2$   
(Both nucleus and alpha particle will have equal and opposite momentum)
- $p = mv \Rightarrow v \propto \frac{1}{m}$   
(alpha particle will move faster due to smaller mass)
- $K.E = \frac{p^2}{2m} \Rightarrow K.E \propto \frac{1}{m}$   
(alpha particle will have greater K.E due to smaller mass)

If two bodies collide with each other and after the collision they move together then their common velocity after the collision is as

$$v = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

**Example:**

A 2500 kg truck moving with velocity  $21 \text{ ms}^{-1}$  collides with a stationary car of mass 1000 kg. The truck and car move together after the impact with common velocity

- (a)  $5 \text{ ms}^{-1}$  (b)  $15 \text{ ms}^{-1}$   
(c)  $10 \text{ ms}^{-1}$  (d)  $20 \text{ ms}^{-1}$

**Solution:**

$$v = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

$$v = \frac{2500 \times 21 + 1000 \times 0}{2500 + 1000}$$

$$v = 15 \text{ ms}^{-1}$$

**ELASTIC COLLISION**

- > A collision in which total K.E of the system is conserved is called elastic collision.
- > A bouncing ball will rebound to its original height.
- > During elastic collision none of K.E is converted into other forms of energy such as sound energy, heat energy etc.

**Inelastic Collision:**

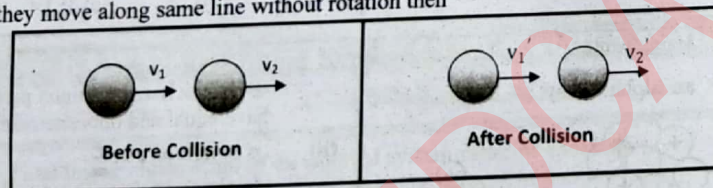
- > A collision in which total K.E of the system is not conserved is called inelastic collision.
- > A bouncing ball will not rebound to its original height.
- > K.E is converted into other forms of energy.

**Note:**

Total Energy and momentum remain conserved in both elastic and inelastic collisions.

**ELASTIC COLLISION IN ONE DIMENSION**

Consider two non-rotating balls moving in same direction collide with each other and after the collision they move along same line without rotation then



$$v_1 + v_1' = v_2 + v_2'$$

(If any three velocities are given you can find the fourth)

- > Relative velocities before and after the collision have same magnitude but opposite direction.

$$v_1 - v_2 = -(v_1' - v_2')$$

- > Magnitudes of relative velocity of approach is equal to magnitude of relative velocity of separation.
- > Velocities after the collisions are:

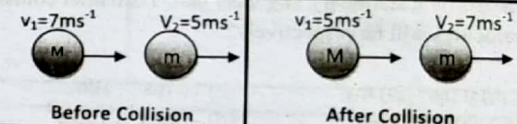
$$v_1' = \frac{(m_1 - m_2)v_1 + 2m_2 v_2}{m_1 + m_2}$$

$$v_2' = \frac{2m_1 v_1 + (m_2 - m_1)v_2}{m_1 + m_2}$$

**Four Special Cases****1<sup>st</sup> Case:**

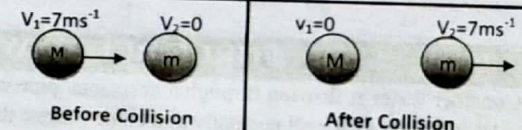
When two bodies of equal mass collide with each other they exchange their velocities after collision.

$$M = m$$

**2<sup>nd</sup> Case:**

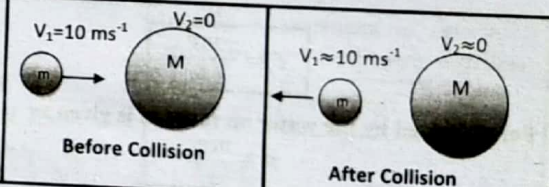
When a moving ball collides with a stationary ball of equal mass they exchange their velocities after collision.

$$M = m$$

**3<sup>rd</sup> Case:**

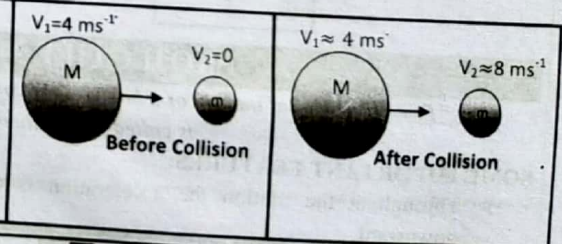
When a moving lighter ball collides with heavier ball initially at rest then after the collision lighter ball moves backward with same velocity while heavier ball will remain at rest

$$m \ll M$$

**4<sup>th</sup> Case:**

When a moving heavier ball collides with lighter ball initially at rest then after the collision velocity of heavier ball remains same while lighter ball will move with double velocity of heavier ball

$$M \gg m$$



**Example:**

A 70 g ball is moving with a velocity of  $9 \text{ ms}^{-1}$  collides elastically with another ball of mass 140 g which is initially at rest. Then after collision their velocities will be respectively?

- (a)  $3 \text{ ms}^{-1}$ ,  $-6 \text{ ms}^{-1}$  (b)  $-3 \text{ ms}^{-1}$ ,  $6 \text{ ms}^{-1}$   
 (c)  $6 \text{ ms}^{-1}$ ,  $-3 \text{ ms}^{-1}$  (d)  $-6 \text{ ms}^{-1}$ ,  $3 \text{ ms}^{-1}$

Solution:  $V_2=0$ 

$$v_1' = \frac{(m_1 - m_2)v_1}{m_1 + m_2}$$

$$v_1' = \frac{(70 - 140)9}{70 + 140} = -3 \text{ ms}^{-1}$$

$$v_2' = \frac{2m_1v_1}{m_1 + m_2}$$

$$v_2' = \frac{2 \times 70 \times 9}{70 + 140} = 6 \text{ ms}^{-1}$$

**Example:**

A 100 g golf ball is moving with velocity of  $20 \text{ ms}^{-1}$  collides elastically a stationary 8kg steel ball. Then after collision their velocities will be respectively?

- (a)  $0 \text{ ms}^{-1}$ ,  $20 \text{ ms}^{-1}$  (b)  $10 \text{ ms}^{-1}$ ,  $10 \text{ ms}^{-1}$   
 (c)  $-20 \text{ ms}^{-1}$ ,  $0 \text{ ms}^{-1}$  (d)  $-10 \text{ ms}^{-1}$ ,  $10 \text{ ms}^{-1}$

Solution:  $V_2=0$ 

$$v_1' = \frac{(m_1 - m_2)v_1}{m_1 + m_2}$$

$$v_1' = \frac{(100 - 8000)20}{100 + 8000} = -19.5 \text{ ms}^{-1}$$

$$v_2' = \frac{2m_1v_1}{m_1 + m_2}$$

$$v_2' = \frac{2 \times 100 \times 20}{100 + 8000} = 0.5 \text{ ms}^{-1}$$

**FORCE DUE TO WATER FLOW**

Consider water is flowing through a horizontal pipe with velocity  $v$  strikes a wall normally and comes to rest then

Force exerted by the wall on the water is given as

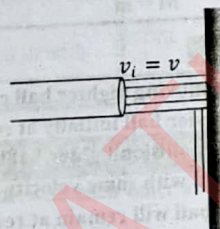
$$F = \frac{mv_f - mv_i}{t}$$

$$F = \frac{-mv}{t}$$

Force exerted by the water on the wall is given as

$$F = \frac{mv_i}{t}$$

$$F = \frac{m}{t}v$$

**PROJECTILE MOTION**

"Two dimensional motion of a body under constant acceleration due to gravity is called projectile motion".

**SOME IMPORTANT FEATURES:**

- Throughout the motion the acceleration is constant ( $a = g$ ) and directed vertically downward.

- Vertical components of velocity continuously changes with time.
- Horizontal component of the velocity always remains constant.
- Horizontal component of acceleration remains zero.
- For **short range** the trajectory or path of projectile is **parabola**.
- For **long range** the trajectory or path of projectile is **elliptical**.

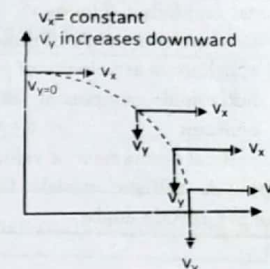
**Case-1:**

If a body is projected in horizontal direction with velocity  $v_x$ .

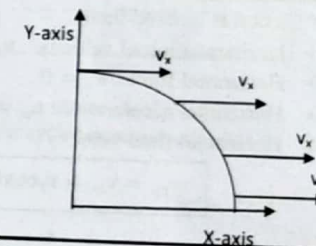
- It moves forward due to inertia.
- It moves downward due to gravity

**Example:** A bomber moving in horizontal direction drops a bomb when it is just above its target but he misses the target due to

- (a) horizontal velocity (b) inertia  
 (c) gravity (d) both a and b ✓

**Horizontal Motion:**

- If air friction is ignored then force along X-axis remains zero:  $F_x = 0$
- Horizontal component of acceleration is always zero.  $a_x = 0$
- Horizontal component of velocity remains constant (horizontal component of velocity is same at all the points)

**Vertical Motion:**

- Force along y-axis:  $F_y = mg$
- Acceleration along y-axis:  $a_y = g$
- Initial vertical velocity is zero and it increases with time.
- Vertical final velocity:  $v_{fy} = gt$

OR

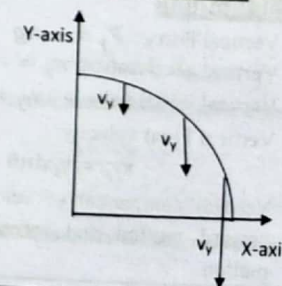
$$v_{fy} = \sqrt{2gh}$$

- Vertical distance:

$$h = \frac{1}{2}gt^2$$

Initially y-component of velocity is zero then increases linearly with time

$$v_{fy} = gt$$



➤ Resultant acceleration:  $a = \sqrt{a_x^2 + a_y^2} = \sqrt{0 + g^2} = g$

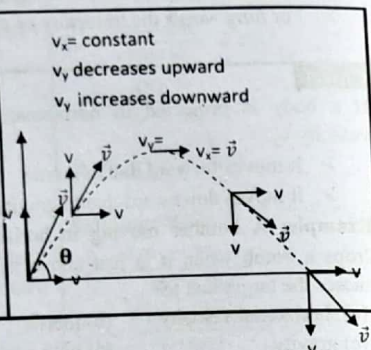
➤ Resultant velocity:  $v = \sqrt{v_x^2 + v_y^2} = \sqrt{v_x^2 + g^2 t^2} = \sqrt{v_x^2 + 2gh}$

**Case-2:**

Consider Body is projected at an angle " $\theta$ " with the horizontal and initial velocity  $v_i$

- $\theta$  is known as angle of projection
- $v_i$  is known as velocity of projection
- horizontal component of velocity remains constant
- vertical component of velocity vary with time

**Example:** A ballistic missile fired from a certain distance at a certain angle.

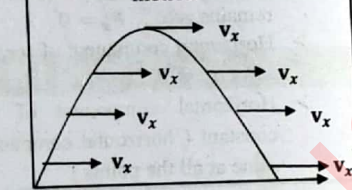
**Horizontal motion:**

If air friction is ignored then.

- Horizontal initial velocity:  $v_{ix} = v_i \cos \theta$
- Horizontal force:  $F_x = 0$
- Horizontal acceleration:  $a_x = 0$
- Horizontal final velocity:

$$v_{fx} = v_{ix} = v_i \cos \theta$$

Horizontal component of velocity remains constant throughout the motion



➤ Resultant acceleration:  $a = \sqrt{a_x^2 + a_y^2} = \sqrt{0 + (-g)^2} = g$

Resultant velocity:  $v = \sqrt{v_{fx}^2 + v_{fy}^2} = \sqrt{(v_i \cos \theta)^2 + (v_i \sin \theta - gt)^2}$

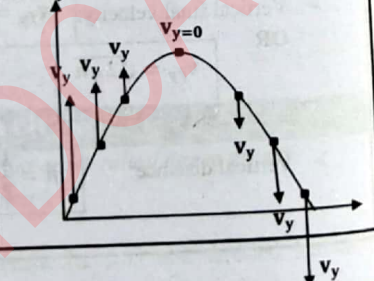
**Vertical motion:**

- Vertical Force:  $F_y = -mg$
- Vertical acceleration:  $a_y = -g$
- Vertical initial velocity:  $v_{iy} = v_i \sin \theta$
- Vertical Final velocity:

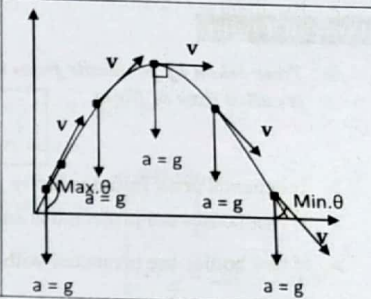
$$v_{fy} = v_i \sin \theta - gt$$

- Vertical component of velocity decreases in upward motion and increases in downward motion

At maximum height the y-component of velocity is zero but velocity is not zero

**Angle between velocity & acceleration:**

- Angle between velocity and acceleration of projectile is maximum at point of projection.
- Angle between velocity and acceleration decreases with time.
- At maximum height velocity and acceleration are perpendicular to each other.
- At the point where the body hits the ground the angle between velocity and acceleration is minimum.

**At max height**

- Y-component of velocity = 0.
- Velocity is minimum and  $v = v_i \cos \theta$ .
- Angle between velocity and acceleration is  $90^\circ$ .

$$K.E = \frac{1}{2} m (v_i \cos \theta)^2 = \frac{1}{2} m v_i^2 \cos^2 \theta$$

$$P.E = mgh = mg \left( \frac{v_i^2 \sin^2 \theta}{2g} \right) = \frac{1}{2} m v_i^2 \sin^2 \theta$$

**Maximum Height:**

(Maximum distance covered by a projectile in vertical direction is called maximum height)

$$H = \frac{v_i^2 \sin^2 \theta}{2g}$$

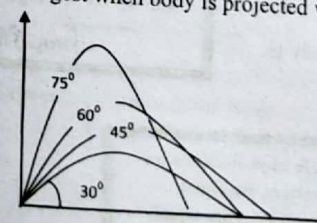
- It depends upon initial velocity, angle of projection and acceleration due to gravity.
- If two bodies are projected at same angle then

$$H \propto v_i^2 \quad \text{and} \quad \left( \frac{H_1}{H_2} = \frac{v_1^2}{v_2^2} \right)$$

- If two bodies are projected with same speed then

$$H \propto \sin^2 \theta \quad \text{and} \quad \left( \frac{H_1}{H_2} = \frac{\sin^2 \theta_1}{\sin^2 \theta_2} \right)$$

- H is largest when body is projected vertically upward ( $\theta = 90^\circ$ ) and  $H_{max} = \frac{v_i^2}{2g}$ .



یاد رکھیں  
Angle جتنا  $90^\circ$  کے قریب ہو گا Height اتنی زیادہ ہو گی۔

**Time of Flight:**

- Time taken by projectile from its point of projection to the point where it hit the ground is called time of flight.

$$t = \frac{2v_1 \sin \theta}{g}$$

- It depends upon initial velocity, angle of projection and acceleration due to gravity.
- If two bodies are projected at same angle then  $t \propto v_1$  ( $\frac{t_1}{t_2} = \frac{v_1}{v_2}$ ).
- If two bodies are projected with same speed then  $t \propto \sin \theta$  ( $\frac{t_1}{t_2} = \frac{\sin \theta_1}{\sin \theta_2}$ ).
- It is largest when body is projected vertically upward ( $\theta = 90^\circ$ ) and  $t_{\max} = \frac{2v_1}{g}$ .

**Note**

Time to reach maximum height is  $\frac{v_1 \sin \theta}{g}$ .

**یاد رکھیں**

Angle جتنا  $90^\circ$  کے قریب ہوگا Body اتنی زیادہ دیر ہوا میں رہے

**Horizontal Range:**

Maximum distance covered by projectile in horizontal direction is called range.

$$R = v_{1x} t \quad \text{or} \quad R = \frac{v_1^2 \sin 2\theta}{g}$$

- It depends upon initial velocity, angle of projection and acceleration due to gravity.

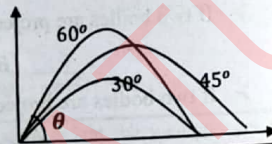
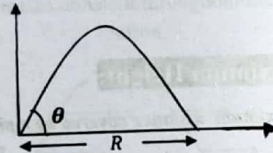
- If two bodies are projected with same speed then

$$R \propto \sin 2\theta \quad \text{and} \quad \left( \frac{R_1}{R_2} = \frac{\sin 2\theta_1}{\sin 2\theta_2} \right)$$

- If bodies are projected at same angle then

$$R \propto v_1^2 \quad \text{and} \quad \left( \frac{R_1}{R_2} = \frac{v_1^2}{v_2^2} \right)$$

- Range of projectile is maximum when body is projected at  $45^\circ$  and  $R_{\max} = \frac{v_1^2}{g}$



یاد رکھیں: Angle جتنا  $45^\circ$  کے قریب ہوگا Range اتنی زیادہ ہوگی۔

**Note:** For some of initial speed, angle of projections for which  $\theta_1 + \theta_2 = 90^\circ$ , Horizontal ranges are equal.

**Example:** At  $30^\circ$  and  $60^\circ$  horizontal ranges are equal.

**Relation between maximum height and range:**

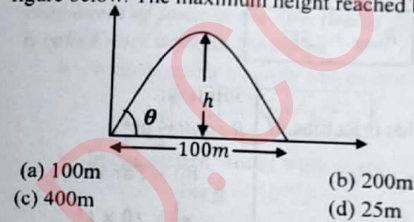
$$H = \frac{1}{4} R \tan \theta$$

- $H = \frac{1}{4} R_{\max}$  (For maximum range  $\theta = 45^\circ$  and  $\tan 45^\circ = 1$ )

- For  $\theta = 76^\circ$  maximum height and range are equal.

**Example:**

The trajectory of a ball thrown at an angle of  $45^\circ$  is shown in the figure below. The maximum height reached by the ball is

**Solution:**

$$H = \frac{1}{4} R \tan \theta$$

$$= \frac{1}{4} \times 100 \times \tan 45^\circ$$

$$H = 25m$$

**Example:**

The range of projectile will be four times the height of projectile at an angle of

- (a)  $25^\circ$  (b)  $45^\circ$  ✓ (c)  $76^\circ$  (d)  $82^\circ$

**Solution:**

$$H = \frac{1}{4} R \tan \theta$$

$$H = \frac{1}{4} \times 4H \tan \theta$$

$$\tan \theta = 1 \text{ or } \theta = 45^\circ$$

**Example:**

If the range of projectile and height of projectile are related as  $R = \frac{4H}{\sqrt{3}}$  then angle of projection will be

- (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  ✓ (d)  $76^\circ$

**Solution:**

$$H = \frac{1}{4} R \tan \theta$$

$$H = \frac{1}{4} \times \frac{4H}{\sqrt{3}} \tan \theta$$

$$\tan \theta = \sqrt{3}$$

**Relation between maximum height and time of flight:**

$$H = \frac{1}{8} g t^2$$

**Example:**

If the ratio between time of flight of two different bodies is 2:3 then the ratio between their maximum height will be

- (a) 2:3 (b) 4:9 ✓ (c)  $\sqrt{2}:\sqrt{3}$  (d) 1:1

**Solution:**

$H \propto t^2$   
Ratio between height is determined by taking square of the ratio between time

**Example:**

If time of flight of a projectile is four seconds the maximum height reached by projectile is

- (a) 10m (b) 20m ✓ (c) 40m (d) 50m

**Solution:**

$$H = \frac{1}{8}gt^2$$

$$H = \frac{1}{8} \times 10 \times (4)^2$$

$$H = 20m$$

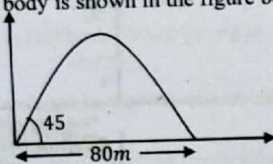
**Relation between Range and Time of flight:**

$$R \tan \theta = \frac{1}{2}gt^2$$

$$R_{\max} = \frac{1}{2}gt^2$$

**Example:**

Trajectory of a body is shown in the figure below. What is its time of flight?



- (a) 4sec (b) 8sec (c) 16 sec (d)  $\sqrt{8}$ sec

**Solution:**

$$R \tan \theta = \frac{1}{2}gt^2$$

$$80 \times \tan 45$$

$$= \frac{1}{2} \times 10 \times t^2$$

$$t^2 = 16$$

**Ballistic Flight:**

Ballistic flight is that in which projectile is given an initial push and then allowed to move freely due to inertia and under action of gravity.

**Ballistic Missile:**

The unpowered and unguided missile is called ballistic missile.

- The ballistic missiles are useful only for short ranges.
- Powered and remote controlled guided missiles are used for long ranges and greater precision.

**Ballistic Trajectory:**

The path followed by ballistic missile is called ballistic trajectory.

If we consider earth as a flat surface, the shape of trajectory is parabolic and its range is short.

If we consider earth spherical, the shape of trajectory is elliptical.

**UNIT 02 >>****WORK AND ENERGY****WORK DONE BY CONSTANT FORCE**

"The product of magnitude of displacement and component of force in the direction of displacement is called work done on the body."

- Work is scalar quantity and its unit is Joule.

$$1J = \text{Kgm}^2\text{s}^{-2}$$

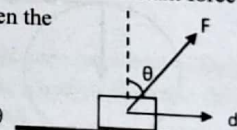
- In cgs system unit of work is erg.

$$1\text{erg} = 10^{-7}J$$

**Example:**

If a body is moving under the action of constant force as shown in the figure below then the work done on the body is

- (a)  $Fd \cos \theta$  (b)  $Fd \sin \theta$   
(c)  $Fd \tan \theta$  (d)  $-Fd \cos \theta$

**Example:**

At what angle between force and displacement more work is done.

- (a)  $20^\circ$  ✓ (b)  $40^\circ$   
(c)  $60^\circ$  (d)  $80^\circ$

**Example:**

At what angle between force and displacement the work done on the body is just 50% of maximum work

- (a)  $30^\circ$  (b)  $45^\circ$   
(c)  $60^\circ$  (d)  $90^\circ$

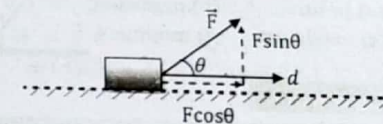
**Positive work :**

If the angle between force and displacement is less than  $90^\circ$  then work is positive.

**Example:**

If the angle between force and displacement of the body is  $30^\circ$  then work done will be

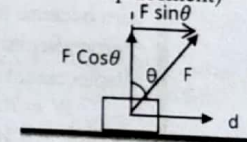
- (a) positive ✓ (b) maximum (c) negative (d) minimum



$$W = (F \cos \theta)(d)$$

$$W = Fd \cos \theta = \vec{F} \cdot \vec{d}$$

**Solution:**  $W = \text{displacement}(\text{component of force parallel to displacement}) = Fd \sin \theta$

**Solution:**

smaller the angle, larger the value of  $\cos \theta$   
Work will be maximum when angle is smallest

**Solution:**

Sine value of  $\cos 60^\circ = 1/2$   
Hence work done is 50% when  $\theta = 60^\circ$

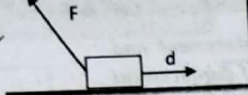
**Negative work :**

If the angle between force and displacement is greater than  $90^\circ$  then work is negative.  
(Work done by friction is always negative).

**Example:**

If a body is moving under the action of constant force as shown in the figure below then the work done on the body is

- (a) positive (b) negative✓  
(c) maximum (d) minimum

**Solution:**

Since the angle between force and displacement is greater than  $90^\circ$ .  
Hence work done will be negative.

**Zero work :**

1. If the angle between force and displacement is  $90^\circ$  then work is zero.

**Example:**

Work done by magnetic force on a moving charge in a magnetic field is always

- (a) positive (b) negative (c) zero✓ (d) none of these

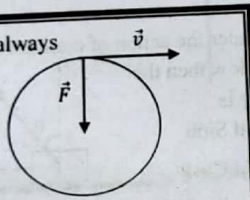
**Solution:**

Magnetic force on a moving charge is always perpendicular to velocity or displacement.

Work done by centripetal force is always zero because force is always Perpendicular to velocity or displacement of the body.

$$W = Fd \cos 90^\circ$$

$$W = 0$$



2. If the body covers no displacement then work is zero.

**Example:**

Work done by a man pushing the rigid wall is zero because

- (a) force is zero (b)✓ displacement is zero  
(c) force and displacement are parallel (d) force and displacement are perpendicular
3. If force acting on the body is zero (body is moving with uniform velocity or speed) then work done on it is zero

**Example:**

If a car is moving with uniform velocity then work done on the car by Engine, Friction and net force is respectively

- (a) positive, negative, positive  
(b) positive, negative, negative  
(c) positive, negative, zero✓  
(d) positive, zero, positive

**Solution:**

Work done by Engine =  $Fd \cos 0^\circ = +Fd$ .

Work done by Friction =  $Fd \cos 180^\circ = -Fd$ .

Net work done = 0

(As car is moving with uniform velocity so  $a = 0$  and  $F_{net} = 0$ )

**Work done in term of rectangular components**

$$W = \vec{F} \cdot \vec{d} = (F_x d_x + F_y d_y + F_z d_z)$$

**Example:**

If a force  $\vec{F} = 4\hat{i} + 6\hat{j}$  displaces the body from point  $p(2, 3)$  to a point  $Q(5, -2)$  then what is work done.

- (a) 9 J (b) -9 J  
(c) 18 J (d) -18 J

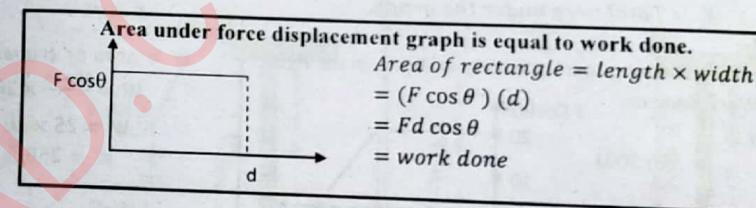
**Solution:**

$$\vec{d} = \vec{r}_f - \vec{r}_i$$

$$= (5\hat{i} - 2\hat{j}) - (2\hat{i} + 3\hat{j}) = 3\hat{i} - 5\hat{j}$$

$$W = \vec{F} \cdot \vec{d} = (4\hat{i} + 6\hat{j}) \cdot (3\hat{i} - 5\hat{j})$$

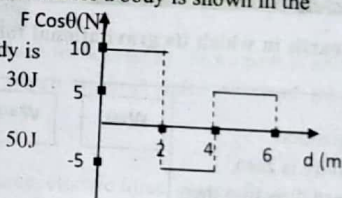
$$= (4)(3) + (6)(-5) = -18 \text{ J}$$

**Example:**

The graph between displacement and component of force in the direction of displacement for a body is shown in the figure below.

Work done on the body is

- (a) 20 J (b) 30 J  
(c) 40 J (d) 50 J

**Solution:**

$$W = \text{total area}$$

$$W = (10 \times 2) - (2 \times 5) + (2 \times 5)$$

$$W = 20 - 10 + 10$$

$$W = 20 \text{ J}$$

**WORK DONE BY VARIABLE FORCE**

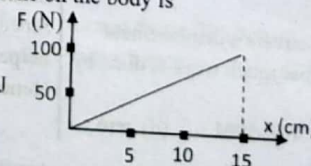
In most cases force is not constant throughout the displacement but it is variable.

**Examples:**

- (i) In stretching a spring. Work is done by variable force ( $F \propto x$ ).

**Example:** Force - displacement graph for a body is shown in the figure below. Work done on the body is

- (a) 7.5 J (b) 15 J  
(c) 750 J (d) 1500 J

**Solution:**

$$W = \text{area of triangle}$$

$$W = \frac{1}{2} \times 100 \times 15 \times 10^{-2}$$

$$W = 7.5 \text{ J}$$

- (ii) A rocket moving away from earth. Work is done by variable force ( $F \propto \frac{1}{r^2}$ ).
- (iii) Two positive point charges are brought closer to each other. Work is done by variable force ( $F \propto \frac{1}{r^2}$ ).

To calculate work done by variable force there are two methods.

- I. we divide the path into small intervals so that in each interval force approximately remains constant then we calculate work done during each interval by using relation

$$W_i = \vec{F}_i \cdot \Delta \vec{d}_i = F_i \Delta d_i \cos \theta_i \text{ then}$$

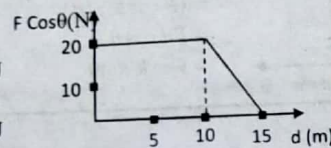
$$W_t = \sum_{i=1}^n F_i \Delta d_i \cos \theta_i$$

- II. We plot a graph between force and displacement and
- $$W_t = \text{Total area under the graph.}$$

**Example:**

Force – displacement graph for a body is shown in the figure below. Work done on the body is

- (a) 50J (b) 200J  
(c) 150J (d) 250J



**Solution:**

$$W = \text{area of trapezium}$$

$$W = \frac{10+15}{2} \times 20$$

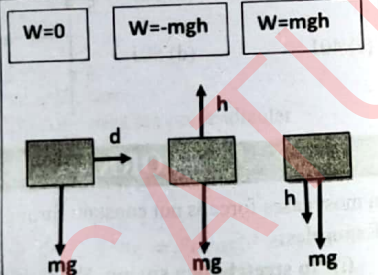
$$W = 25 \times 10$$

$$W = 250\text{J}$$

## WORK DONE BY GRAVITATIONAL FORCE

- Region or space around the earth in which its gravitational force acts on the body is called **gravitational field**.

- In the Gravitational Field:
- (i) If a body is displaced in horizontal direction, work done by gravity is zero.
- (ii) If body is displaced in upward direction then work done by gravity is negative ( $W = -mgh$ ).
- (iii) If body is displaced in downward direction then work done by gravity is positive ( $W = mgh$ ).



**Example:**

A person holding a 10kg bag covers a displacement 5m in horizontal direction. How much work is done by gravity

- (a) 50J (b) 500J (c) -500J (d) zero

**Solution:**

Since force of gravity is perpendicular to displacement Hence work is zero

- (i) Work done by gravity is independent of path followed.

**Along path1:**

$$W_{AB} = W_{AD} + W_{DB} = 0 + (-mgh) = -mgh$$

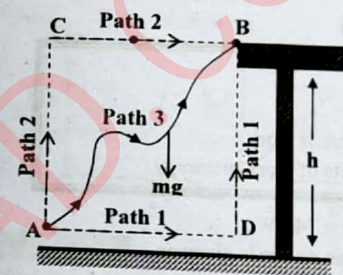
**Along path2:**

$$W_{AB} = W_{AC} + W_{CB} = (-mgh) + 0 = -mgh$$

**Along path3:**

$$W_{AB} = -mg(\text{total vertical displacement})$$

$$W_{AB} = -mgh$$

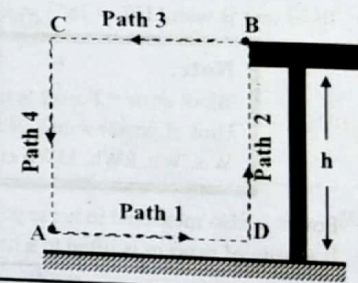


- (i) Work done by Gravity in a closed path is zero.

$$W_{ADBCA} = W_{AD} + W_{DB} + W_{BC} + W_{CA}$$

$$W_{ADBCA} = 0 + (-mgh) + 0 + (+mgh)$$

$$W_{ADBCA} = 0$$



## Conservative Force:

- The force for which work done in closed path is zero is called conservative force.
- The force for which work is independent of the path followed by the body is called conservative force.

**Examples:**

Gravitational force, electric force, elastic force, are conservative forces.

## Non-Conservative Force:

- Work done depends upon the path followed (Longer the path, larger the work).
- Work done in closed path is not equal to zero.
- Work done on aeroplane by air friction is not zero in a closed path and longer the path followed by aero plane, larger the work done by air friction.

**Examples:**

- Friction, Viscous force, Normal force, Tension, Air resistance, Propulsive force of rocket and motor are non-conservative forces.

## POWER

"Rate at which work is being done."

OR Work done by a body per unit time is called power of the body."

➤ Average power:

$$P_{av} = \frac{\text{Total work}}{\text{Total time}} = \frac{W}{t}$$

➤ It is a scalar quantity. It is equal to dot product of force and velocity.

$$P = \vec{F} \cdot \vec{v} = Fv \cos \theta$$

➤ Its SI unit is watt ( $1W = Js^{-1} = kgm^2s^{-3}$ ).

**Note:**

Work done = Power  $\times$  time

Unit of power  $\times$  unit of time = unit of work

W.s, Wh, kWh, MWh etc. are units of work or energy.

- Power is also measured in horse power. (1hp = 746 W)  
 ➤ If a body of mass  $m$  is lifted to a height  $h$  then power is given as

$$P = \frac{mgh}{t}$$

If work done is equal to change in K.E

$$P = \frac{\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2}{t}$$

If work done is equal to change in P.E

$$P = \frac{mgh_2 - mgh_1}{t}$$

**Kilo-Watt Hour:**

"One Kilowatt hour is work done in one hour by an agency whose power is one kilowatt."

$$1Wh = 3.6 \text{ kJ} \quad 1kWh = 3.6Mj \quad 1MWh = 3.6Gj$$

Kilowatt hour is the commercial unit of electrical energy.

## ENERGY

Capacity of a body to do work is called energy.

- There are many types of energy such as K.E, P.E, sound energy, heat energy, electrical energy, chemical energy, solar energy etc.  
 ➤ Mechanical energy can either be K.E or P.E  
 ➤ It is a scalar quantity  
 ➤ Its SI unit is joule ( $1J = N.m = kg m^2s^{-2}$ )  
 ➤ Work and energy have same units.

## Kinetic Energy

"Energy possessed by a body due to its motion is called kinetic energy."

➤ Kinetic energy cannot be negative.

In terms of velocity

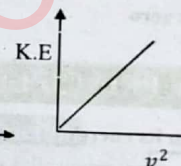
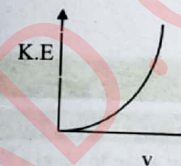
$$K.E = \frac{1}{2}mv^2$$

It depends upon mass of the body and its velocity

$$K.E \propto v^2$$

And

$$K.E \propto m$$



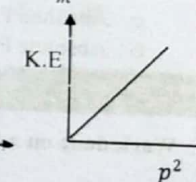
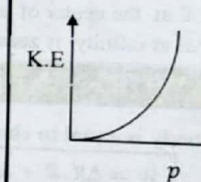
In terms of momentum

$$K.E = \frac{p^2}{2m}$$

And

$$K.E \propto p^2$$

$$K.E \propto \frac{1}{m}$$



## Potential Energy

Energy possessed by a body due to its position in the force field or due to its constrained state.

- P.E is always determined relative to some reference point where P.E is taken zero.  
 ➤ Reference point can be chosen anywhere.

**NOTE:**

P.E due to force of attraction is always negative  
 P.E due to force of repulsion is always positive

Examples:

- Gravitational  $P.E = mgh$  (if surface of earth is taken as a reference point)
- Absolute gravitational  $P.E = -\frac{GMm}{r}$  (if reference point is taken at infinity where force of gravity is zero)
- Elastic  $P.E = \frac{1}{2}kx^2$
- Electrical P.E between two point charges  $= \frac{kq_1q_2}{r}$
- Electrical P.E stored in capacitor  $= \frac{1}{2}CV^2$
- Magnetic P.E stored in an Inductor  $= \frac{1}{2}LI^2$
- Energy stored in compressed or stretched spring is called elastic P.E.

## ABSOLUTE POTENTIAL ENERGY

**"Absolute P.E at any point is defined as work done by gravitational field in moving the object from that point to infinity where force of gravity becomes zero."**

- Absolute P.E at any distance  $r$  from the center of earth is given as

$$P.E = -\frac{GMm}{r}$$

(absolute P.E is always negative)

- Absolute P.E on the surface of earth is given as

$$P.E = -\frac{GMm}{R}$$

- Absolute P.E at any height  $h$  from the surface of earth is given as

$$P.E = -\frac{GMm}{R+h} \quad (\text{by increasing the height absolute P.E increases})$$

- Absolute P.E at the center of earth is zero.

- Absolute P.E at infinity is zero.

## WORK ENERGY PRINCIPLE

Work done on a body is equal to change in its energy.

$$W = \Delta K.E + \Delta P.E$$

- If work done on the body is positive then its energy increases.
- If work done on the body is negative then its energy decreases.
- If work done on the body is zero then its energy remains constant.

### Case 1:

If work done by conservative force is zero then  $P.E=0$  and

$$W = \Delta K.E$$

OR  $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

- If work done on the body is positive then its K.E increases.
- If work done on the body is negative then its K.E decreases.
- If work done on the body is zero then its K.E remains constant.

If body is accelerated from rest then  $v_i = 0$

$$Fd = \frac{1}{2}mv_f^2$$

If body is brought to rest  $v_f = 0$

$$Fd = -\frac{1}{2}mv_i^2$$

### Case 2:

If work is done by conservative force while keeping the body in equilibrium then  $K.E=0$  and

$$W = \Delta P.E$$

OR

$$W = mgh_2 - mgh_1$$

- If work done on the body is positive then its P.E increases.
- If work done on the body is negative then its P.E decreases.
- If work done on the body is zero then its P.E remains constant.

### Example:

If 1000N force is required to stop a car moving with velocity  $10\text{ms}^{-1}$  then the force required to stop the car in same distance when it is moving with velocity  $20\text{ms}^{-1}$  will be

- (a) 500N
- (b) 1000N
- (c) 2000N
- (d) 4000N

### Example:

What is force required to accelerate an object of mass 1kg from rest to a velocity  $4\text{ms}^{-1}$  in a distance 10m

- (a) 0.4 N
- (b) 0.8 N
- (c) 4 N
- (d) 8 N

### Solution:

$$Fd = -\frac{1}{2}mv_i^2$$

As 'd' and are same so  
 $F \propto v^2$

If  $v$  is doubled then  $F$  becomes  
4 times ( $4 \times 1000 = 4000\text{N}$ )

### Solution:

$$Fd = \frac{1}{2}mv_f^2$$

$$F \times 10 = -\frac{1}{2} \times 1(4)^2$$

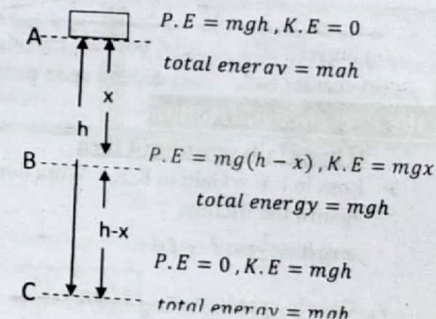
$$F = 0.8\text{N}$$

## INTERCONVERSION OF K.E AND P.E

### In the absence of air friction

If a body of mass  $m$  falls under the action of gravity from a height  $h$  as shown in the figure.

- Loss in P.E is equal to gain in K.E.
- Total energy always remains constant.



### After falling downward distance X

- Loss in  $P.E = mgx$
- % loss in  $P.E = \frac{x}{h} \times 100$
- Gain in  $K.E = mgx$
- % Gain in  $K.E = \frac{x}{h} \times 100$
- Gain in speed/velocity  $= \sqrt{2gx}$

### Velocity of object falling under gravity

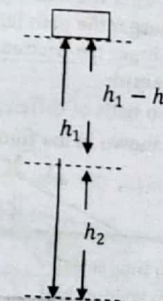
Gain in K.E = loss in P.E

$$\frac{1}{2}m(v_2^2 - v_1^2) = mg(h_1 - h_2)$$

- If at height  $h_1$  body is moving with velocity  $v_1$  then at height  $h_2$  velocity of the body will be

$$v_2 = \sqrt{2g(h_1 - h_2) + v_1^2}$$

If body falls from rest then  $v_1 = 0$



$$v_2 = \sqrt{2g(h_1 - h_2)}$$

$$v \propto \sqrt{(h_1 - h_2)}$$

$$v \propto \sqrt{\text{vertical distance}}$$

- Velocity only depends upon initial and final height and is independent of mass of the body and path followed.
- If body reaches the ground then  $h_1 = 0$

$$v = \sqrt{2gh}$$

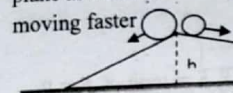
$$v \propto \sqrt{h}$$

### LAW OF CONSERVATION OF ENERGY

Energy cannot be destroyed. It can be transformed from one kind to another but total amount of energy always remains constant.

#### Example:

Two balls of different masses rolls down from a frictionless plane as shown in the figure below then which balls is moving faster



- (a) bigger ball
- (b) smaller ball
- (c) ✓ both are moving with same speed
- (d) depend upon path length

#### Solution:

$$v = \sqrt{2gh}$$

Velocity only depends upon height and is independent of mass of the body and path followed

### In the Presence of friction

#### If body falls downward then

- Loss in P.E = Gain in K.E + Work done against the friction.

$$mgh = \frac{1}{2}mv^2 + fd$$

- Gain in speed:  $v = \sqrt{2\left(gh - \frac{fd}{m}\right)}$
- Larger the mass, greater the speed.
- Larger the path length, smaller the speed.
- Larger the friction, smaller the speed

#### If body is thrown upward then

- Loss in K.E = Gain in P.E + Work done against the friction.

$$\frac{1}{2}mv^2 = mgh + fd$$

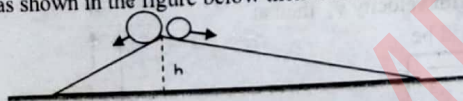
#### Solution:

In presence of friction

- Larger the mass, greater the speed.
- smaller the path, larger the speed

#### Example:

Two balls of different masses rolls down from a rough plane as shown in the figure below then which balls is moving faster



- (a) bigger ball ✓
- (b) smaller ball
- (c) both are moving with same speed
- (d) depend upon path length

## UNIT 03 >>

## ROTATIONAL AND CIRCULAR MOTION

### Circular Motion:

"Motion of a body moving in circular path or motion of a body whose distance from axis of rotation remains constant is called circular motion".

#### Examples:

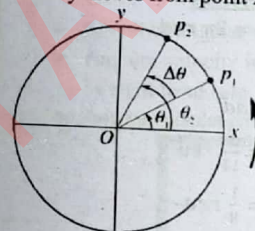
- Motion of satellites around the earth.
- Motion of car moving on a circular track.
- Motion of stone tied with a string, rotating in a circular path.

### ANGULAR DISPLACEMENT

"Angle subtended at the center in small interval of time or angle  $\Delta\theta$  which gives the change in angular position of a body is called angular displacement".

#### Examples:

If body moves from point A to B on circular path then its angular displacement is  $\Delta\theta$



**Note** One radian is the angle between two radii which cut off on the circumference an arc equal to radius

**Note** Rotational motion is either two or three dimensional motion and cannot be one dimensional.

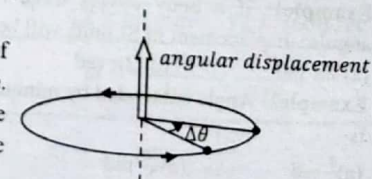
- SI unit of angular displacement is radian and other units are degree, revolution etc.
- For small value, angular displacement is vector quantity.
- For large value angular displacement is not vector because it does not obey the vectors laws such as commutative law ( $\theta_1 + \theta_2 = \theta_2 + \theta_1$ ).

**Example:** if a body moves from one end of the diameter to other then angular displacement of the body will be

- (a)  $90^\circ$
- (b)  $180^\circ$  ✓
- (c)  $270^\circ$
- (d)  $360^\circ$

### Right hand rule :

Direction of angular displacement is along axis of rotation and it is determined by right hand rule. (Rotate fingers in direction of rotation while keeping the thumb erect then thumb indicates the direction of angular displacement).

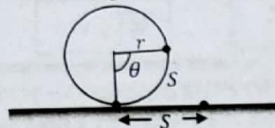


**Rotation between Linear and Angular displacement:**

If a particle moving in circular path of radius  $r$ , covers an arc length  $S$  and angular displacement  $\theta$  then

$$S = r\theta$$

If a body is rolling without slipping then its linear distance is equal to arc length.

**Examples:**

If a wheel of radius 0.5m is rolling without slipping then its linear distance covered in 3-revolutions will be

- (a) 1.5m (b) 2m  
(c) 5.4m (d) 9.4m

**Solution:**

$$s = r\theta = 0.5 \times 3 \times 2\pi = 3\pi \text{ m} = 9.4 \text{ m}$$

(1 rev =  $2\pi \text{ rad}$ )

**Conversion of degree into radian:**

- >  $30^\circ = 30 \times \frac{\pi}{180} = \frac{\pi}{6} \text{ rad}$
- >  $45^\circ = 45 \times \frac{\pi}{180} = \frac{\pi}{4} \text{ rad}$
- >  $60^\circ = 60 \times \frac{\pi}{180} = \frac{\pi}{3} \text{ rad}$

**Conversion of Radian into radian:**

- >  $\frac{\pi}{2} \text{ rad} = \frac{180^\circ}{2} = 90^\circ$
- >  $\pi \text{ rad} = 180^\circ$
- >  $\frac{3\pi}{2} \text{ rad} = \frac{3 \times 180^\circ}{2} = 270^\circ$

**Example1:** if a body covers three revolutions in 5 seconds then its angular displacement in SI units will be

- (a)  $2\pi \text{ rad}$  (a)  $3\pi \text{ rad}$  (a)  $6\pi \text{ rad}$  (a)  $9\pi \text{ rad}$

**Example2:** Angle subtended by minute hand of the clock in 15 minutes is

- (a)  $\frac{\pi}{2} \text{ rad}$  (a)  $\frac{3\pi}{2} \text{ rad}$  (a)  $\frac{6\pi}{5} \text{ rad}$  (a)  $2\pi \text{ rad}$

**Solution:**

$$3 \text{ rev} = 3 \times 2\pi \text{ rad} = 6\pi \text{ rad}$$

**Solution:**

$$\text{Angle in 15 min.} = 90^\circ = \frac{\pi}{2} \text{ rad}$$

پارہ کیس

$$S = r\theta \text{ "صرف تب hold کرے گا جب } \theta \text{ "}$$

وہی Radians میں ہوگی۔

**ANGULAR VELOCITY:**

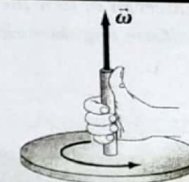
Rate of change of angular displacement of body is called its angular velocity.

Angle ہر سیکنڈ میں ہائی کہتا ہے۔

Average angular velocity is given as

$$\omega = \frac{\text{total angular displacement}}{\text{total time}}$$

$$\omega = \frac{\Delta\theta}{\Delta t}$$



**Example1:** if a body covers three revolutions in 6 seconds then its angular velocity in SI units will be

- (a)  $2\pi \text{ rad}$  (a)  $4\pi \text{ rad}$  (a)  $6\pi \text{ rad}$  (a)  $\pi \text{ rad}$

**Solution:**  $\omega = \frac{\Delta\theta}{\Delta t} = \frac{3 \times 2\pi}{6} = \pi$

- > SI unit of angular velocity is  $\text{rads}^{-1}$  and other units are  $\text{degs}^{-1}$  and  $\text{revs}^{-1}$  etc.
- > Angular velocity is a vector quantity and its direction is along axis of rotation determined by right hand rule.
- > Angular displacement and angular velocity are always parallel.

**Relation with time period**

$$\omega = \frac{2\pi \text{ rad}}{T}$$

(اگر کسی Rotating باڈی کا ٹائم پریڈ معلوم ہو تو اس relation سے  $\omega$  معلوم کریں)

Angular velocity of second hand of clock	$\omega = \frac{2\pi \text{ rad}}{1 \text{ min}} = \frac{2\pi \text{ rad}}{60 \text{ sec}}$
Angular velocity of minute hand of clock	$\omega = \frac{2\pi \text{ rad}}{60 \text{ min}} = \frac{2\pi \text{ rad}}{3600 \text{ sec}}$
Angular velocity of hour hand of clock	$\omega = \frac{2\pi \text{ rad}}{12 \times 60 \text{ min}} = \frac{2\pi \text{ rad}}{12 \times 3600 \text{ sec}}$
Angular velocity of earth around its own axis	$\omega = \frac{2\pi \text{ rad}}{1 \text{ day}} = \frac{2\pi \text{ rad}}{24 \text{ h}}$
Angular velocity of earth around the sun	$\omega = \frac{2\pi \text{ rad}}{1 \text{ year}}$

**Uniform Angular Velocity:**

If body covers equal angular displacement in equal intervals of time then body is rotating with uniform angular velocity.

**Instantaneous Angular velocity:**

Angular velocity of a body at any particular instant of time is called instantaneous angular velocity.

$$\omega = \lim_{\Delta t \rightarrow 0} \frac{\Delta \theta}{\Delta t}$$

**ANGULAR ACCELERATION**

Rate of change of angular velocity of a body is called angular acceleration.

$$\alpha_{av} = \frac{\text{Total change in angular velocity}}{\text{Total time}} = \frac{\Delta \omega}{\Delta t} = \frac{\omega_f - \omega_i}{t}$$

- Angular acceleration is a vector quantity and its direction is always along the direction of direction of torque.
- SI unit of angular acceleration is  $\text{rads}^{-2}$  and other units are  $\text{deg s}^{-2}$  and  $\text{rev s}^{-2}$  etc.

Angular acceleration کا مطلب ہے کہ ہائیگی ہر سیکنڈ میں

Angular velocity بڑھ رہی ہے یا کم ہو رہی ہے۔

Linear acceleration is caused by force, similarly angular acceleration is caused by torque

$$\tau = I\alpha$$

**Uniform Angular Acceleration:**

If angular velocity of a body changes equally in equal intervals of time then body is moving with uniform angular acceleration.

**Instantaneous Angular Acceleration:**

Angular acceleration of a body at any particular instant of time is called instantaneous angular acceleration.

$$\alpha_{ins} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \omega}{\Delta t}$$

If angular velocity is increasing then angular acceleration is positive and parallel to angular velocity.



If  $\omega$  is increasing

If angular velocity is decreasing then acceleration is negative and anti-parallel to angular velocity.



If  $\omega$  is decreasing

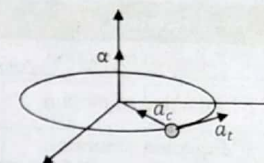
If angular velocity is constant then angular acceleration is zero and net torque acting on the body is also zero



If  $\omega$  is constant

**Note:** A body moving in a circular path may have:

- Tangential acceleration** (due to changing speed of the body).
- Angular acceleration** (due to changing angular velocity of the body).
- Centripetal acceleration** (due to changing direction of linear velocity of the body).
- $a_t$ ,  $a_c$  and  $\alpha$  are always mutually perpendicular.



If body is moving in circular path with uniform speed or uniform angular velocity then body has only centripetal acceleration due to changing direction of velocity and  $\alpha = 0$  and  $a_t = 0$

**RELATION BETWEEN LINEAR AND ANGULAR VARIABLES**

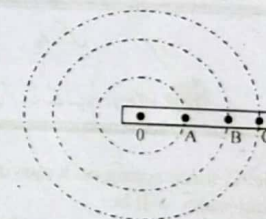
- $S = r\theta$
- $v_t = r\omega$  or  $\vec{v}_t = \vec{r} \times \vec{\omega}$  ( $\vec{v}_t$ ,  $\vec{r}$  and  $\vec{\omega}$  are always perpendicular to each other)
- $a_t = r\alpha$  or  $\vec{a}_t = \vec{r} \times \vec{\alpha}$  ( $\vec{a}_t$ ,  $\vec{r}$  and  $\vec{\alpha}$  are always perpendicular to each other)

**Note:** For a rotating rigid body, all particles of rigid body will have same angular displacement  $\theta$ , angular velocity  $\omega$  and angular acceleration  $\alpha$  but values of  $S$ ,  $v$  and  $a_t$  may be different depending upon the distance  $r$ .

$$\begin{aligned} \theta_A &= \theta_B = \theta_C \\ \omega_A &= \omega_B = \omega_C \\ \alpha_A &= \alpha_B = \alpha_C \end{aligned}$$

But

$$\begin{aligned} S_C &> S_B > S_A \\ v_C &> v_B > v_A \\ a_C &> a_B > a_A \end{aligned}$$

**Equations of motion for angular motion:**

I. Equation:

$$\omega_f = \omega_i + \alpha t$$

without  $\theta$  use 1<sup>st</sup> equation کرنا ہوگا۔

II. Equation:

$$\theta = \omega_i t + \frac{1}{2} \alpha t^2$$

without  $\omega_f$  use 2<sup>nd</sup> equation کرنا ہوگا۔

III. Equation:

$$2\alpha\theta = \omega_f^2 - \omega_i^2$$

without time use 3<sup>rd</sup> equation کرنا ہوگا۔

**Limitations:**

These equations are applicable only if

- Angular acceleration  $\alpha$  is uniform.
- Axis of rotation does not change.

To determine a relation for angular motion from linear motion replace

$S$ by $\theta$	$v$ by $\omega$	$a$ by $\alpha$	$m$ by $I$	$F$ by $\tau$	$p$ by $L$	$K.E$ by $K.E_{rot}$
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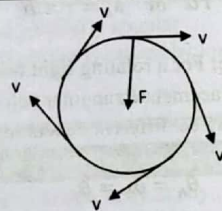
Relation	Linear Motion	Angular Motion
1 <sup>st</sup> Equation of motion	$v_f = v_i + at$	$\omega_f = \omega_i + \alpha t$
2 <sup>nd</sup> Equation of motion	$S = v_i t + \frac{1}{2} at^2$	$\theta = \omega_i t + \frac{1}{2} \alpha t^2$
3 <sup>rd</sup> Equation of motion	$2aS = v_f^2 - v_i^2$	$2\alpha\theta = \omega_f^2 - \omega_i^2$
Newton's 2 <sup>nd</sup> law	$F = ma$ or $F = \frac{\Delta P}{\Delta t}$	$\tau = I\alpha$ or $\tau = \frac{\Delta L}{\Delta t}$
Momentum	$p = mv$	$L = I\omega$
Work done	$W = Fd$	$W = \tau\theta$
Kinetic energy	$K.E = \frac{1}{2} mv^2$	$K.E_{rot} = \frac{1}{2} I\omega^2$

## CENTRIPETAL FORCE

If a body is moving in a circular path then direction of its velocity is continuously changing with time. Hence there must be a force perpendicular to velocity that will change the direction of velocity.

یاد رکھیں

ہاڈی کی سٹیج یا direction کو تبدیل کرنے کے لیے force کا ہونا ضروری ہے۔



**Example:** If force acting on a moving body is zero then its Path or trajectory will be  
(a) straight line (b) circular  
(c) elliptical (d) parabolic

"Force needed to bend the normally straight path of a body into circular path is called centripetal force."

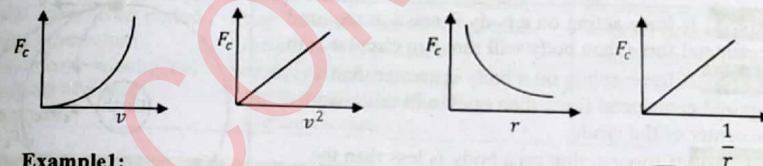
$$F_c = \frac{mv^2}{r}$$

- Centripetal force is required force provided some agent to bend the body in circular path
- Direction of centripetal force is always directed towards the center but its direction is continuously changing with time.
- Centripetal force is always perpendicular to velocity.
- Centripetal force always changes the direction of velocity it cannot change the speed of the body.

➤ Centripetal force depends upon

• Mass of the body	$F_c \propto m$	For greater mass, greater amount of force is required to bend the body in a circular path
• Speed of the body	$F_c \propto v^2$	With greater speed, greater amount of force is required to bend the body in a circular path
• Radius of circular path	$F_c \propto \frac{1}{r}$	greater amount of force is required to bend the body in a circular path of shorter radius

Various types of graph for centripetal force:



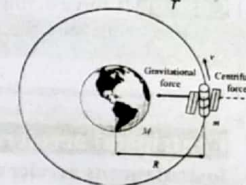
**Example1:**

Satellites revolving around the earth. Force of gravity provide the required centripetal force.

$$F_c = F_g$$

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$v = \sqrt{\frac{GM}{r}}$$

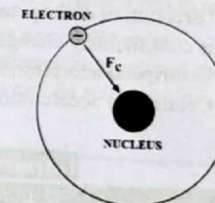


**Example2:**

Electrons revolving around the nucleus. Electric force provides the required centripetal force.

$$F_c = F_e$$

$$\frac{mv^2}{r} = \frac{Kq_1q_2}{r^2}$$



**Example3:**

A stone tied to a string moving in circular path. Tension in string provide required centripetal force.

$$F_c = T$$



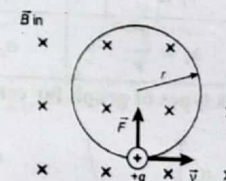
**Example4:**

A charge moving in circular path in a magnetic field. Magnetic field force provides the required centripetal force.

$$F_m = F_c$$

$$qvB = \frac{mv^2}{r}$$

$$r = \frac{qBr}{m}$$



**Example 5:**

A car moving in circular road. Force of friction provides the required centripetal force.

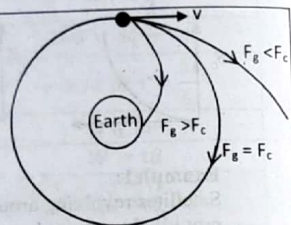
Banked tracks are needed for turns that are taken so quickly that friction alone cannot provide required centripetal force



**Case i.** If force acting on a body is equal to required centripetal force then body will move in circular path.

**Case ii.** If force acting on a body is greater than required centripetal force then body will fall towards the center of the circle.

**Case iii.** If force acting on a body is less than the required centripetal force then body will move out of circular.

**Centripetal acceleration:**

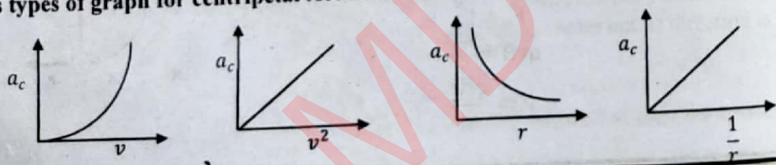
Instantaneous acceleration of the body moving in a circular path with uniform speed is always directed towards the center of the circle. It is known as centripetal acceleration.

- Direction of centripetal acceleration is always directed towards the center but its direction is continuously changing with time.
- Centripetal acceleration is always perpendicular to velocity.
- Centripetal acceleration is due to changing the direction of velocity.

**Important Expressions for Centripetal Force**

In terms of speed	In terms of angular speed	In terms of time period	In terms of momentum	In terms of K.E
$F_c = \frac{mv^2}{r}$ If $v = \text{constant}$ $F_c \propto \frac{1}{r}$	$F_c = mr\omega^2$ If $\omega = \text{constant}$ $F_c \propto r$	$F_c = \frac{4\pi^2 mr}{T^2}$	$F_c = \frac{p^2}{mr}$	$F_c = \frac{2K.E}{r}$
$a_c = \frac{v^2}{r}$	$a_c = r\omega^2$	$a_c = \frac{4\pi^2 r}{T^2}$	$a_c = \frac{p^2}{m^2 r}$	$a_c = \frac{2K.E}{mr}$

Various types of graph for centripetal Acceleration :



Constant quantities	Quantities which are zero	Quantities which are changing direction
Under the action of only centripetal force following quantities remains constant Speed, kinetic energy, angular speed, time period, angular momentum, magnitude of velocity and magnitude of linear momentum	Under the action of only centripetal force following quantities remains zero. Work done, change in kinetic energy, tangential acceleration, angular acceleration, tangential force, torque produced by centripetal force, change in angular velocity and change in angular momentum.	Under the action of only centripetal force magnitude of following remain constant but their direction changes velocity acceleration, momentum and force.

**ORBITAL VELOCITY**

Minimum velocity required to put a satellite in a circular orbit is called orbital velocity.

$$F_c = F_g$$

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$v = \sqrt{\frac{GM}{r}}$$

**Note:**  $v \propto \frac{1}{\sqrt{r}}$  and independent of mass of satellite.

➤ If satellite is revolving around the earth near its surface then  $r = R$

$$v = \frac{GM}{R} = \sqrt{gR} = 7.9 \text{ km/s}$$

and  $T = 5060 \text{ sec} \approx 84 \text{ min}$

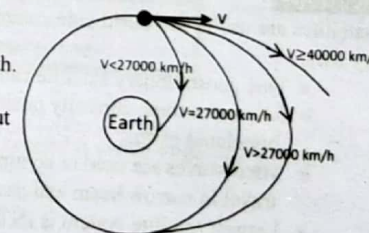
Minimum height of satellite revolving around the earth is 400 km and 24 such satellites form GPS system.

➤ If velocity of satellite is less than critical velocity ( $v < 27000 \text{ km/h}$ ) it will fall towards earth.

➤ If velocity is equal to critical velocity ( $v = 27000 \text{ km/h}$ ) then it will move in circular path.

➤ If velocity is greater than critical velocity but less than escape velocity it will move in an elliptical path.

➤ If velocity is equal or greater than escape velocity it will escape from earth's gravity



## GEOSTATIONARY SATELLITE

"Satellite whose orbital motion is synchronized with the rotation of earth is known as geostationary satellite. And its orbit is known as geostationary orbit".



Orbital speed	Radius of orbit	Height
$v = \sqrt{\frac{GM}{r}}$	$r = \left(\frac{GMT^2}{4\pi^2}\right)^{\frac{1}{3}}$	$h = r - R$
$v = 3.1 \text{ km/s}$	$v = 4.23 \times 10^4 \text{ km}$	$h \approx 36000 \text{ km}$

Time period	Angular velocity	Angular acceleration
$T$	$\omega = \frac{2\pi}{T}$	$\alpha = \frac{\Delta\omega}{\Delta t}$
$T = 1 \text{ day}$ $= 24 \text{ h}$ $= 86400 \text{ sec}$	$\omega = \frac{1 \text{ rev}}{\text{day}}$ $= \frac{2\pi \text{ rad}}{\text{day}}$	Zero

## Applications:

Such satellites are useful for worldwide communication, weather observation, navigation and military uses.

- One geostationary satellite can cover  $120^\circ$  longitude of earth.
- Minimum three correctly positioned satellites are required for complete coverage of populated earth.
- Microwaves are used to communicate with geostationary satellites because they travel in narrow beam and pass easily through atmosphere.
- Largest satellite system is INTELSAT (International Telecommunication Satellite Organization) managed by 126 countries.
- INTELSAT IV has capacity of 30,000 two way telephone calls plus 3 T.V channels and its operates at 4,6,11 and 14 GHz frequencies.

## UNIT 04 &gt;&gt;

## OSCILLATIONS &amp; WAVES

## OSCILLATIONS

## Periodic Motion:

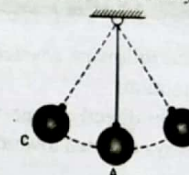
Motion which repeats itself after regular intervals of time is called periodic motion.

## Vibratory Motion:

To and fro motion of a body about its mean position is called vibratory motion.

## Examples:

- Motion of simple pendulum.
- Motion of mass spring system.
- Motion of tuning fork.
- Motion of atoms in solids.



## Amplitude:

Maximum displacement covered by body from its mean position is called amplitude.

## Vibration:

One complete round trip of a body in motion is called one vibration.

## Time period:

Time taken by body to complete one vibration is called time period.

## Frequency:

Number of vibrations executed by a body in one second is called frequency.

$$f = \frac{1}{T}$$

Product of time period and frequency is always equal to one

## Angular Frequency:

Number of revolutions executed by a body in one second is called angular frequency.

$$\omega = \frac{2\pi}{T}$$

$$\omega = 2\pi f$$

**Example:** Angular frequency of second pendulum is

- (a)  $2\pi \text{ rev s}^{-1}$  (b)  $2\pi \text{ Hz}$   
(c)  $\pi \text{ Hz}$  (d)  $2\pi \text{ rad s}^{-1}$

**Solution:** As time period of simple pendulum is 2sec

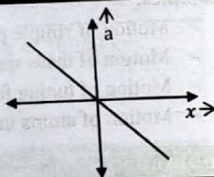
$$\omega = \frac{2\pi}{2} = \pi \text{ rad s}^{-1}$$

No. of vibrations	Distance	Displacement	Time taken	Move from
$\frac{1}{4}$ vib	$x_0$	$x_0$	$\frac{T}{4}$	Mean to extreme
$\frac{1}{2}$ vib	$2x_0$	Zero	$\frac{T}{2}$	Mean to extreme
$\frac{3}{4}$ vib	$3x_0$	$x_0$	$\frac{3T}{4}$	Mean to left extreme
1 vib	$4x_0$	Zero	$T$	Mean to mean

## SIMPLE HARMONIC MOTION

Simple harmonic motion has following characteristics:

- Always vibratory motion.
- Acceleration is always directly proportional to displacement.
- Acceleration is always directed towards mean position.



$$a \propto -x$$

## Note

The graph between acceleration and displacement is a straight line in II and IV quadrant.

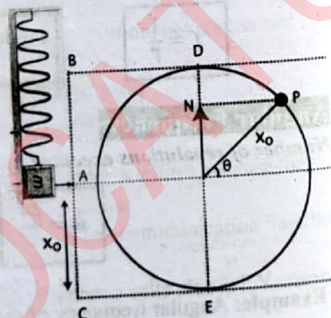
## Examples:

Mass spring system executes SHM.

Simple pendulum is executing SHM for small amplitude.

## SHM &amp; UNIFORM CIRCULAR MOTION

- Mass spring system executes SHM with amplitude  $X_0$  and time period  $T$ .
- If point P is moving in circular path with uniform speed or uniform angular velocity then its periodic but not SHM.
- Projection N of the point P is oscillating on vertical axis and is executing SHM.



**Example:** Projection of a point on any diameter executes simple harmonic motion if the point is moving in a circular path with

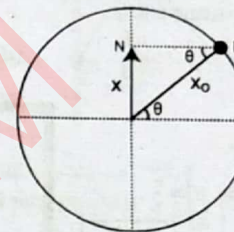
- (a) uniform speed ✓ (a) variable speed (a) uniform acceleration (d) none of these

## Instantaneous displacement:

From the figure:

$$\sin \theta = \frac{x}{x_0}$$

$$x = x_0 \sin \theta$$



## Types of Questions:

1. Find displacement when  $\theta$  is given OR Find  $\theta$  (phase) when displacement is given.

## Example1:

What is displacement of a body executing SHM when its phase is  $\frac{\pi}{6}$  rad.

- (a)  $\frac{x_0}{2}$  (b)  $\frac{x_0}{\sqrt{2}}$  (a)  $\frac{\sqrt{3}x_0}{2}$  (d)  $x_0$

## Solution:

$$x = x_0 \sin \theta$$

$$x = x_0 \sin \frac{\pi}{6} = x_0 \sin 30^\circ$$

$$= \frac{x_0}{2}$$

## Example2:

If a body is executing SHM then find the value of  $\theta$  for which displacement is 70% of maximum displacement.

- (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $70^\circ$

## Solution:

$$x = x_0 \sin \theta = 0.7x_0 = \frac{x_0}{\sqrt{2}}$$

$$\Rightarrow \sin \theta = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \theta = 45^\circ = \frac{\pi}{4} \text{ rad}$$

2. Find displacement when time is given OR Find the time when displacement is given.

## Example:

What is displacement of body at instant  $t = \frac{T}{8}$  where  $T$  is time period of the a body executing SHM.

- (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $70^\circ$

## Solution:

$$t = \frac{T}{8} \Rightarrow \theta = \frac{\pi}{4} = 45^\circ$$

$$x = x_0 \sin \theta$$

$$\Rightarrow x = \frac{x_0}{\sqrt{2}}$$

## Alternate Solution

$$x = x_0 \sin \theta = x_0 \sin \omega t = x_0 \sin \frac{2\pi}{T} \times \left(\frac{T}{8}\right)$$

$$= x_0 \sin \frac{\pi}{4} = x_0 \sin 45^\circ$$

$$= \frac{x_0}{\sqrt{2}}$$

## SHORT CUT

Time سے  $\theta$  کی ویلیو معلوم کرنے کیلئے  $T$  کی جگہ  $\pi$  اور نیچے والی ویلیو کو half کر دیں۔

**Example:**

The time taken by body executing SHM from its mean position to half of its extreme position.

- (a)  $\frac{T}{4}$  (b)  $\frac{T}{6}$  (c)  $\frac{T}{8}$  (d)  $\frac{T}{12}$

**Solution:**

$$x = x_0 \sin \theta$$

$$x = \frac{x_0}{2} \Rightarrow \theta = 30^\circ = \frac{\pi}{6}$$

$$\Rightarrow t = \frac{T}{12}$$

**Alternate Solution:**

$$x = \frac{x_0}{2} \Rightarrow x_0 \sin \theta = \frac{x_0}{2} \Rightarrow \theta = \frac{\pi}{6}$$

$$\Rightarrow \omega t = \frac{\pi}{6} \Rightarrow \frac{2\pi}{T} t = \frac{\pi}{6} \Rightarrow t = \frac{T}{12}$$

**SHORT CUT**

Time سے  $\theta$  کی دہائی معلوم کرنے کے لیے  $\pi$  کی جگہ  $T$  اور  
نچے والی دہائی کو double کر دیں۔

**Example:**

The time taken by body executing SHM from its extreme position to a point midway between mean and extreme position.

- (a)  $\frac{T}{4}$  (b)  $\frac{T}{6}$  (c)  $\frac{T}{8}$  (d)  $\frac{T}{12}$

**Solution:**

$$x = x_0 \cos \theta$$

$$x = \frac{x_0}{2} \Rightarrow \theta = 60^\circ = \frac{\pi}{3}$$

$$\Rightarrow t = \frac{T}{6}$$

**Alternate Solution:**

$$x = \frac{x_0}{2} \Rightarrow x_0 \sin \theta = \frac{x_0}{2} \Rightarrow \theta = \frac{\pi}{6}$$

$$\Rightarrow \omega t = \frac{\pi}{6} \Rightarrow \frac{2\pi}{T} t = \frac{\pi}{6} \Rightarrow t = \frac{T}{12}$$

When motion starts from extreme position then use the relation

$$x = x_0 \cos \theta$$

**3. Comparison type questions.**

$$x = x_0 \sin(\omega t + \phi)$$

Amplitude      Angular frequency      Initial phase

**Example:** Displacement for a body executing SHM is given as  $x = 10 \sin(4t)$   
Find amplitude, maximum velocity, maximum acceleration, angular frequency, time period, frequency and initial phase.

**Solution:**

Compare the equation  $x = 10 \sin(4t)$  with standard equation  $x = x_0 \sin(\omega t + \phi)$

$$\text{Amplitude} = x_0 = 10$$

$$\text{Maximum velocity} = x_0 \omega = (10)(4) = 40$$

$$\text{Time period} = T = \frac{2\pi}{\omega} = \frac{\pi}{2}$$

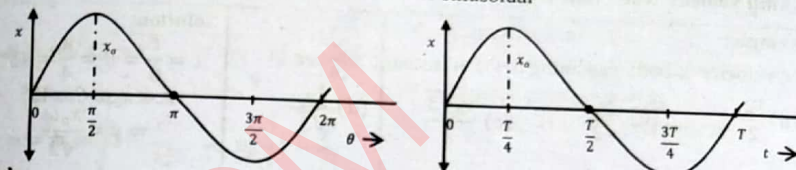
$$\text{Max. acceleration} = x_0 \omega^2 = (10)(4)^2 = 160$$

$$\text{Angular frequency} = \omega = 4$$

$$\text{Initial phase} = 0$$

$$\text{Frequency} = f = \frac{1}{T} = \frac{2}{\pi}$$

**Graph:** The graph between  $x$  and  $\theta$ , or  $x$  and time is sinusoidal

**Example:**

Displacement time graph of a body executing SHM is shown in the figure below. The value of amplitude and time period is



- (a) 10cm, 4s (b) 4cm, 10s (c) 20cm, 2s (d) 20cm, 4s

**Instantaneous Velocity:**

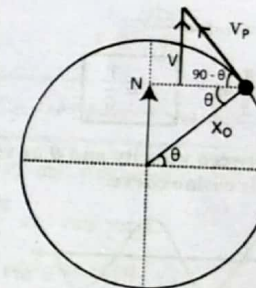
Velocity of point P is always directed along tangent to the circle and **vertical** component of its velocity is the velocity of projection which is executing SHM.  
From the figure:

$$\sin(90^\circ - \theta) = \frac{v}{v_p}$$

$$\cos \theta = \frac{v}{v_p}$$

$$v = v_p \cos \theta$$

$$v = x_0 \omega \cos \theta$$

**Types of Questions:**

1. Find velocity when  $\theta$  is given OR find  $\theta$  when velocity is given.

**Example:**

What is velocity of the body executing SHM when its phase angle is  $30^\circ$ .

- (a)  $\frac{v_0}{2}$  (b)  $\frac{v_0}{\sqrt{2}}$  (c)  $\frac{v_0 \sqrt{3}}{2}$  (d)  $\frac{v_0}{\sqrt{3}}$

**Solution:**

$$v = x_0 \omega \cos \theta$$

$$v = x_0 \omega \cos 30^\circ$$

$$= \frac{x_0 \omega \sqrt{3}}{2} = \frac{v_0 \sqrt{3}}{2}$$

**Example:**

The value of  $\theta$  for which velocity of a body executing SHM is  $\frac{v_0}{2}$

- (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $90^\circ$

**Solution:**

$$v = x_0 \omega \cos \theta$$

$$v = \frac{v_0}{2} \Rightarrow \theta = 60^\circ = \frac{\pi}{3}$$

## 2. Find velocity when time is given OR find time when velocity is given.

Example:

The velocity of body executing SHM at instant  $t = \frac{T}{8} \text{ sec}$ 

(a)  $\frac{v_0}{2}$  (b)  $\frac{v_0}{\sqrt{2}}$  (c)  $\frac{v_0\sqrt{3}}{2}$  (d)  $\frac{v_0}{\sqrt{3}}$

Solution:

$$t = \frac{T}{8} \Rightarrow \theta = \frac{\pi}{4} = 45^\circ$$

$$v = x_0 \omega \cos 45^\circ$$

$$\Rightarrow v = \frac{x_0 \omega}{\sqrt{2}}$$

Example:

At what instant velocity of a body executing SHM is half of its maximum value.

(a)  $\frac{T}{4}$  (b)  $\frac{T}{6}$  (c)  $\frac{T}{8}$  (d)  $\frac{T}{12}$

Solution:

$$v = x_0 \omega \cos \theta$$

$$v = \frac{v_0}{2} \Rightarrow \theta = 60^\circ$$

$$\Rightarrow \theta = \frac{\pi}{3} \Rightarrow t = \frac{T}{6}$$

Alternate Solution:

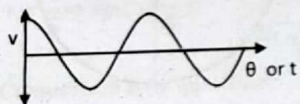
$$v = \frac{v_0}{2} \Rightarrow v_0 \cos \theta = \frac{v_0}{2} \Rightarrow \cos \theta = \frac{1}{2}$$

$$\Rightarrow \theta = \frac{\pi}{3} \Rightarrow \omega t = \frac{\pi}{3}$$

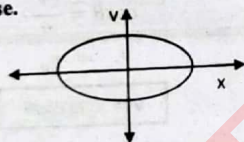
$$\Rightarrow \frac{2\pi}{T} t = \frac{\pi}{3} \Rightarrow t = \frac{T}{6}$$

## SHORT CUT

Time  $\theta$  کی دیکھ کر معلوم کرنے کیلئے  $\pi$  کی جگہ  $T$  اور نیچے والی دیکھ کر double کر دیں۔  
Time  $\theta$  کی دیکھ کر معلوم کرنے کیلئے  $\pi$  کی جگہ  $T$  اور نیچے والی دیکھ کر half کر دیں۔

Graph between velocity and  $\theta$  or velocity and time is cosine curve.

Graph between velocity and displacement is an ellipse.



## 3. Comparison type questions.

$$v = v_0 \cos(\omega t + \phi)$$

Max velocity:  $v_0$   
Angular frequency:  $\omega$   
Initial phase:  $\phi$

**Example:** velocity of a body executing SHM is given as  $v = 10 \cos 2t$ . Find amplitude, maximum velocity, maximum acceleration, angular frequency, time period, frequency and initial phase.

**Solution:** compare the equation  $v = 10 \cos 2t$  with the standard equation  $v = v_0 \cos(\omega t + \phi)$

i. $v_0 = 10$	ii. $\omega = 2$
iii. $x_0 = \frac{v_0}{\omega} = \frac{10}{2} = 5$	iv. $a_0 = x_0 \omega^2 = 5(2)^2 = 20$
v. $T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi$	vi. $T = \frac{1}{f} = \frac{1}{\omega/2\pi} = \frac{2\pi}{\omega} = \pi$

## 4. Velocity In terms of displacement:

$$v = \omega \sqrt{x_0^2 - x^2} = \omega \sqrt{x_0^2 - \frac{x^2}{x_0^2}}$$

$$v = x_0 \omega \sqrt{1 - \frac{x^2}{x_0^2}} = v_0 \sqrt{1 - \frac{x^2}{x_0^2}}$$

- At mean position  $x = 0$   
 $\Rightarrow v = x_0 \omega$  (maximum)
- At mean position  $x = x_0$   
 $\Rightarrow v = 0$  (minimum)

➤ Speed of projection increases when it is moving towards center of the circle and its speed decreases when it is moving away from the center of circle

Example:

If a body is executing SHM then at what displacement velocity is half of its maximum velocity.

(a)  $\frac{v_0}{2}$  (b)  $\frac{v_0}{\sqrt{2}}$   
(c)  $\frac{v_0\sqrt{3}}{2}$  (d)  $\frac{v_0}{\sqrt{3}}$

Solution:

$$v = \omega \sqrt{x_0^2 - x^2} \Rightarrow \frac{x_0 \omega}{2} = \omega \sqrt{x_0^2 - x^2}$$

$$\Rightarrow \frac{x_0}{2} = \sqrt{x_0^2 - x^2} \Rightarrow \frac{x_0^2}{4} = (x_0^2 - x^2)$$

$$\Rightarrow x^2 = x_0^2 - \frac{x_0^2}{4} \Rightarrow x^2 = \frac{3x_0^2}{4}$$

$$x = \frac{\sqrt{3}x_0}{2}$$

Alternate short cut solution:

direct displacement  $\propto$  Velocity  
 ➤ Replace  $v_0$  by  $x_0$  and vice versa.

As

$$v = \frac{v_0}{2}$$

$$\Rightarrow x = \frac{x_0\sqrt{3}}{2}$$

- Replace  $\frac{1}{2}$  by  $\frac{\sqrt{3}}{2}$  and vice versa.
- Replace 0 by 1 and vice versa.
- Replace  $\frac{1}{\sqrt{2}}$  by  $\frac{1}{\sqrt{3}}$

## Instantaneous Acceleration:

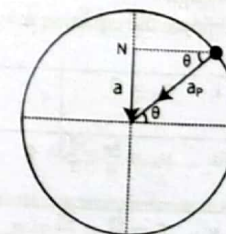
- Since point P is moving in circular path with uniform speed hence it only possesses centripetal acceleration directed towards the center of the circle.
- Its vertical component is acceleration of projection N executing SHM. From the figure:

$$\sin \theta = \frac{a}{a_p} \quad \text{or} \quad a = a_p \sin \theta$$

$$a = x_0 \omega^2 \sin \theta$$

$$\ddot{x} = -\omega^2 x$$

$$a = x_0 \omega^2 \sin \omega t$$



1. Find acceleration when  $\theta$  is given OR find  $\theta$  when acceleration is given.

**Example:**

Acceleration of a body executing SHM at angle  $30^\circ$  is

- (a)  $\frac{\sqrt{3}a_0}{2}$  (b)  $\frac{a_0}{\sqrt{2}}$  (c)  $\frac{a_0}{2}$  (d)  $a_0$

**Solution:**

$$a = x_0 \omega^2 \sin 30^\circ$$

$$a = \frac{x_0 \omega^2}{2} = \frac{a_0}{2}$$

**Example:**

For which of  $\theta$  acceleration of a body executing SHM is  $\frac{x_0 \omega^2}{\sqrt{2}}$

- (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $90^\circ$

2. Find time when acceleration is given and vice versa.

**Example:**

Acceleration of a body executing SHM at instant  $t = \frac{T}{6}$  is

- (a)  $\frac{\sqrt{3}a_0}{2}$  (b)  $\frac{a_0}{\sqrt{2}}$  (c)  $\frac{a_0}{2}$  (d)  $a_0$

**Solution:**

$$a = x_0 \omega^2 \sin \theta$$

$$a = \frac{x_0 \omega^2}{\sqrt{2}} \Rightarrow \theta = 45^\circ$$

**Solution:**

$$t = \frac{T}{6} \Rightarrow \theta = \frac{\pi}{3} = 60^\circ$$

$$a = x_0 \omega^2 \sin \theta$$

$$\Rightarrow a = \frac{x_0 \omega^2 \sqrt{3}}{2} = \frac{a_0 \sqrt{3}}{2}$$

**Example:**

At what instant the acceleration of the body is  $\frac{x_0 \omega^2}{2}$  or  $\frac{a_0}{2}$

- (a)  $\frac{T}{4}$  (b)  $\frac{T}{6}$  (c)  $\frac{T}{8}$  (d)  $\frac{T}{12}$

**Solution:**  $a = x_0 \omega^2 \sin \theta$

$$a = \frac{a_0}{2} \Rightarrow \theta = 30^\circ$$

$$= \frac{\pi}{6} \Rightarrow t = \frac{T}{12}$$

3. Comparison type questions:

$$a = a_0 \sin(\omega t + \phi)$$

Max. acceleration      Angular frequency      Initial phase

**Example:** acceleration of a body executing SHM is given as  $a = 8 \sin 2t$ . Find amplitude, maximum velocity, maximum acceleration, angular frequency, time period, frequency and initial phase.

**Solution:**

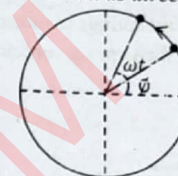
Compare the equation  $a = 8 \sin 2t$  with the standard equation  $a = a_0 \sin(\omega t + \phi)$

i. $a_0 = 8$	ii. $\omega = 2$
iii. $v_0 = \frac{a_0}{\omega} = \frac{8}{2} = 4$	iv. $x_0 = \frac{a_0}{\omega^2} = \frac{8}{4} = 2$
v. $T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi$	vi. $T = \frac{1}{f} = \frac{1}{\pi}$

## PHASE

Angle of  $\theta$  which specifies the displacement as well as direction of motion of a body executing SHM is called phase.

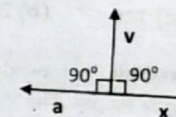
- Initial phase at  $t = 0 = \phi$
- phase during the time  $t = \omega t$
- Total phase =  $\omega t + \phi$



Motion starts $t = 0$ from	Initial phase	Displacement	Velocity	Acceleration
.....	$\phi$	$x = x_0 \sin(\omega t + \phi)$	$v = x_0 \omega \cos(\omega t + \phi)$	$a = -x_0 \omega^2 \sin(\omega t + \phi)$
Mean position	$\phi = 0$	$x = x_0 \sin \omega t$	$v = x_0 \omega \cos \omega t$	$a = -x_0 \omega^2 \sin \omega t$
Extreme position	$\phi = 90^\circ$	$x = x_0 \cos \omega t$	$v = -x_0 \omega \sin \omega t$	$a = -x_0 \omega^2 \cos \omega t$

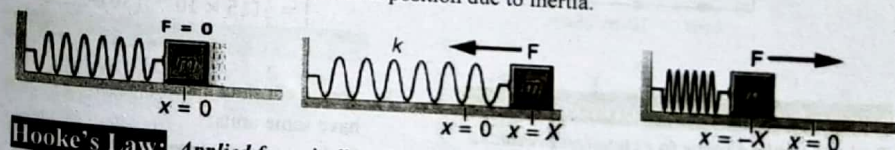
**Note:**

- Phase difference between displacement and velocity is  $90^\circ$ .
- Phase difference between velocity and acceleration is  $90^\circ$ .
- Phase difference between displacement and acceleration is  $180^\circ$ .



## MASS SPRING SYSTEM

- Mass spring system executes simple harmonic motion.
- Restoring force brings the body back towards mean position.
- Body does not come to rest at mean position due to inertia.



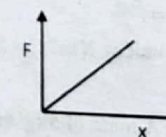
**Hooke's Law:** Applied force is directly proportional to extension produced in spring.

$$F \propto x$$

OR

$$F = kx$$

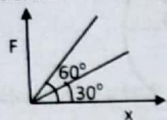
- The graph between force and extension is a straight line.
- Slope of the graph represents the spring constant.
- Area under force-extension graph represents the work done or P.E.



- جس گراف کی slope زیادہ ہے اس کا spring constant بھی زیادہ ہوگا۔
- جس گراف کے نیچے Area زیادہ ہوگا۔ اس کی P.E. زیادہ ہوگا۔

**Example:**

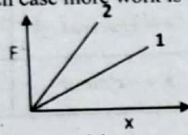
Force-extension graph for two different springs is shown in the figure below. Find the ratio between their spring constants.



- (a)  $1:\sqrt{3}$  (b)  $\sqrt{3}:1$  (c)  $1:3$  (d)  $3:1$

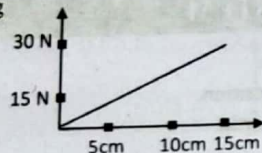
**Example:**

Force-extension graph for two different springs is shown in the figure below. In which case more work is done.



- (a) 1st (b) 2nd (c) same (d) zero in both

**Example:** Force-extension graph for a spring is shown in the figure below. The value of spring constant and P.E stored in the spring

**Spring Constant or Force constant :**

Ratio of applied force to extension produced in spring is known as spring constant.

- $K = \frac{F_{ext}}{x}$
- SI unit =  $Nm^{-1} = kgms^{-2}$

**Example:** A mass of 5kg suspended with a vertical spring produces 2cm extension in the spring. The spring constant of the spring will be

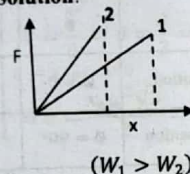
- (a)  $500 Nm^{-1}$  (b)  $5000 Nm^{-1}$  (c)  $2500 Nm^{-1}$  (d)  $250 Nm^{-1}$

**Solution:**

$$K = \text{slope} = \tan \theta$$

$$\frac{K_1}{K_2} = \frac{\tan 30^\circ}{\tan 60^\circ}$$

$$= \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$$

**Solution:****Solution:**

$$K = \frac{F}{x} = \frac{30N}{15cm}$$

$$= \frac{30N}{15 \times 10^{-2}m} = 200 Nm^{-1}$$

$$W = \text{Area}$$

$$= \frac{1}{2} (15 \times 10^{-2})(30) = 2.25J$$

- Spring constant and surface tension have same units.
- Spring constant depends upon temperature and nature of the material.
- Spring constant is independent of applied force and extension produced in spring.

**Solution:**

$$k = \frac{F}{x}$$

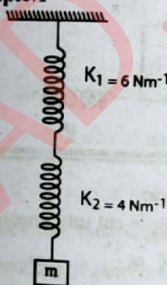
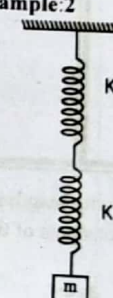
$$= \frac{mg}{x} = \frac{5 \times 10}{2 \times 10^{-2}} = 2500 Nm^{-1}$$

**Series Combination of Springs**

If springs are connected end to end this combination is known as series combination

**Equivalent Spring Constant**

1.  $K_{eq} = \frac{K}{n}$  (اگر "n" different value والے پرنگ سیریز میں گئے ہوں)
2.  $K_{eq} = \frac{K_1 K_2}{K_1 + K_2} = \frac{\text{Product}}{\text{sum}}$  (اگر دو different value والے پرنگ سیریز میں گئے ہوں)
3.  $\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \dots$  (اگر three different value والے پرنگ سیریز میں گئے ہوں)

**Example: 1****Example: 2****NOTE:**

Equivalent spring constant series is less than minimum spring constant.

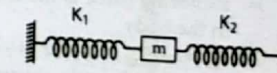
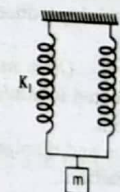
And to decrease the spring constant springs are connected in series

$$K_{eq} = \frac{K}{n} = \frac{K}{2}$$

**Parallel Combination of Springs**

If springs are connected side by side then this combination is known as parallel combination

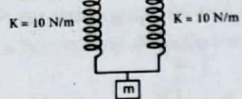
Spring کا ایک end سپورٹ کے ساتھ اور دوسرا end لٹاؤں کے ساتھ جڑاؤ

**Equivalent Spring Constant**

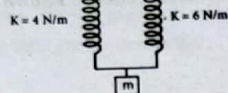
If springs are connected side by side then equivalent spring constant is given as :

1.  $K_{eq} = nK$  (If "n" no. of springs having same value are connected in parallel)
2.  $K_{eq} = K_1 + K_2 + \dots$  (If springs having different values are connected in parallel)
3.  $K_{eq} = K_{max}$
4. To increase spring constant springs are connected in parallel.

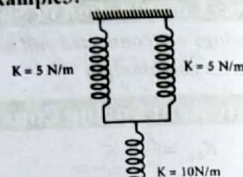
## Example 1:



## Example 2:



## Example 3:

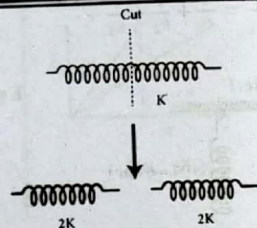


## Note:

If a spring of spring constant  $K$  is cut into ' $n$ ' equal parts then spring constant of each part will be ' $nK$ '

## Example:

If spring of spring constant  $K$  is cut into two equal parts then spring constant of each part will be  $2K$ .



**Examples:** If spring is cut into two parts having length in the ratio 1:2 then the ratio between spring constants of the part will be.

- a) 1:2    ✓ b) 2:1    c) 1:4    d) 4:1

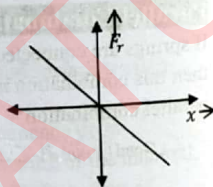
## Solution:

If spring is cut into unequal parts then ( $K \propto \frac{1}{l}$ ) ratio in  $k$  will be opposite to  $l$

## Restoring Force:

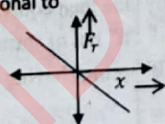
Force which brings the body back towards its mean position.

- Restoring force is the force which produces acceleration in the body.
- $F_r = -F_{ext} = -Kx = -m\omega^2 x$  ( $K = m\omega^2$ )
- Restoring force is always directed towards mean position and is opposite to displacement.
- Graph between restoring force and displacement is a straight line in 2<sup>nd</sup> and 4<sup>th</sup> Quadrant.



**Example:** The graph between restoring force and displacement is shown in the figure. Slope of the graph is directly proportional to

- (a)  $\omega$     (b)  $\omega^2$   
(b)  $1/\omega$     (d)  $1/\omega^2$



## Solution:

As  $F_r = -m\omega^2 x$

$$\text{slope} = \frac{F_r}{x} = -m\omega^2$$

$$\text{slope} \propto \omega^2$$

## Acceleration:

As

$$F_r = -Kx$$

$$ma = -Kx$$

$$a = -\frac{K}{m}x$$

$$\text{max. acceleration} = -\frac{K}{m}x_0$$

$$\Rightarrow a \propto -x$$

Hence mass spring system is executing simple harmonic motion.

## Angular Frequency:

$$\text{As } a = -\frac{K}{m}x$$

$$-\omega^2 x = -\frac{K}{m}x (\because a = -\omega^2 x)$$

$$\omega = \sqrt{\frac{K}{m}}$$

## Note:

Angular frequency only depends upon spring constant and mass suspended and independent of amplitude and gravity.

## Time Period:

or

$$\text{As } T = \frac{2\pi}{\omega}$$

$$T = 2\pi \sqrt{\frac{m}{K}}$$

$$T \propto \sqrt{m} \quad \text{and} \quad T \propto \frac{1}{\sqrt{K}}$$

**Note:** Time period only depends upon spring constant and mass suspended and independent of amplitude and gravity.

## Frequency:

$$f = \frac{1}{2\pi} \sqrt{\frac{K}{m}}$$

$$f \propto \sqrt{K} \quad \text{and} \quad f \propto \frac{1}{\sqrt{m}}$$

**Note:** Frequency only depends upon spring constant and mass suspended and independent of amplitude and gravity.

If spring is being vertically then we may write  $F = mg$

$$\Rightarrow Kx = mg \Rightarrow \frac{m}{K} = \frac{x}{g}$$

$$T = 2\pi \sqrt{\frac{x}{g}} \quad \text{and} \quad f = \frac{1}{2\pi} \sqrt{\frac{g}{x}}$$

Since now  $x \propto g$  hence time period and frequency are still independent of gravity.

**Example:** If a 2kg mass suspended with a vertical spring produces 10cm extension in the spring. If it is set into oscillations its time period will be

- (a)  $\omega$     (b)  $\omega^2$   
(b)  $1/\omega$     (d)  $1/\omega^2$

$$\text{Solution: } T = 2\pi \sqrt{\frac{x}{g}}$$

$$= 2\pi \sqrt{\frac{10}{10 \times 100}} = \frac{\pi}{5}$$

Displacement:	Velocity:
Instantaneous displacement for mass spring system is given as $x = x_o \sin \omega t$ $\Rightarrow x = x_o \sin \sqrt{\frac{k}{m}} t$ max. displacement = $x_o$	$v = \omega \sqrt{x_o^2 - x^2} = \sqrt{\frac{k}{m} \sqrt{x_o^2 - x^2}}$ $= \sqrt{\frac{k}{m} (x_o^2 - x^2)} = \sqrt{\frac{k}{m}} x_o \sqrt{1 - \frac{x^2}{x_o^2}}$ $v = v_o \sqrt{1 - \frac{x^2}{x_o^2}}$ max. velocity $v_o = x_o \omega = x_o \sqrt{\frac{k}{m}}$

## SIMPLE PENDULUM

Simple pendulum consists of small heavy mass suspended with a light and intensible string whose other end is fixed with rigid support.

$\ell$  = length of pendulum

$\theta$  = Angular displacement with vertical axis

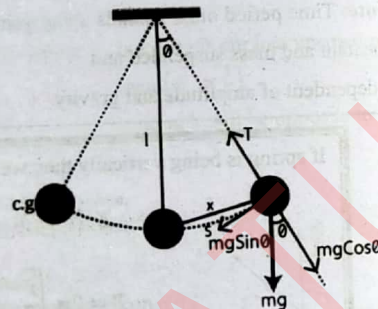
$s$  = distance from mean position

$x$  = displacement from mean position

$mg$  = weight

$mg \cos \theta$  = component along the string

$mg \sin \theta$  = component perpendicular to the string



## Tension in String:

Since no acceleration is produced along the string hence net force along the string is zero.

$$T - mg \cos \theta = 0$$

$$T = mg \cos \theta$$

- At mean position ( $\theta = 0$ ) tension is maximum and equal to weight  $T = mg \cos 0 = mg$
- At extreme position ( $\theta = \text{maximum}$ ) Tension is minimum.
- If angular displacement  $\theta$  is very small then  $\cos \theta \approx 1$  and  $T \approx mg \approx \text{constant}$ .

## Restoring Force:

The component  $mg \sin \theta$  brings the body back towards its mean position

$$F_r = -mg \sin \theta$$

- -ve sign indicates that it is directed towards the mean position.
- Torque acting on pendulum is  $mg \ell \sin \theta$

If pendulum makes an angle  $\theta$  with the horizontal instead of vertical then

Tension in string is

$$T = mg \cos \theta$$

Restoring force is

$$F_r = -mg \cos \theta$$

Acceleration	Angular Frequency:
$ma = -mg \sin \theta$ $a = -g \sin \theta$ ➤ If angle $\theta$ is very small ➤ $\sin \theta \approx \theta \approx \frac{x}{\ell}$ ( $\because \theta = \frac{s}{r}$ ) $a = -g \frac{x}{\ell}$ OR $a \propto -x$ Simple pendulum executes SHM for small angular displacement ' $\theta$ '.	$a = -g \frac{x}{\ell}$ $-\omega^2 x = \frac{g}{\ell} x \Rightarrow \omega^2 = \frac{g}{\ell}$ $\omega = \sqrt{\frac{g}{\ell}}$ $\omega \propto \sqrt{g}$ and $\omega \propto \frac{1}{\sqrt{\ell}}$ Note: (i) Angular frequency only depends upon length of pendulum and acceleration due to gravity. (ii) It is independent of amplitude and mass of the bob.

## Time Period

$$\text{As } T = \frac{2\pi}{\omega}$$

Or

$$T = 2\pi \sqrt{\frac{\ell}{g}}$$

$$\Rightarrow T \propto \sqrt{\ell} \text{ and } T \propto \frac{1}{\sqrt{g}}$$

Note:

- T only depends upon length and acceleration due to gravity.
- T is independent of amplitude and mass of the body.

## Frequency:

$$\text{As } f = \frac{1}{T}$$

$$\Rightarrow f = \frac{1}{2\pi} \sqrt{\frac{g}{\ell}}$$

$$\Rightarrow T \propto \sqrt{g} \text{ and } T \propto \frac{1}{\sqrt{\ell}}$$

Note:

- Frequency only depends upon length and acceleration due to gravity.
- Frequency is independent of amplitude and mass of the body.

**Second Pendulum:**

A pendulum whose time period is two seconds is called second pendulum.  
 $T = 2\text{sec}$ ,  $f = 0.5\text{ Hz}$ ,  $\ell = 99.3\text{ cm}$  (when  $a = 9.8\text{ ms}^{-2}$ )

**Example1:** If time period of second pendulum on surface of earth is two seconds. Then time period of second pendulum on surface of moon will be  
 (a) 2sec (b)  $2\sqrt{6}\text{ sec}$  (c)  $2/\sqrt{6}\text{ sec}$  (d) infinity

**Solution:** Two second

کسی بھی جگہ second pendulum کا ٹیڑھا ہوتا ہے تو وہ  
 بیش 2 sec ہو گا۔

**Example2:**

If time period of second pendulum on earth is two seconds and it is shifted to moon then its time period will be (value of  $g_{\text{moon}} = \frac{g_{\text{earth}}}{6}$ )  
 (a) 2sec (b)  $2\sqrt{6}\text{ sec}$  (c)  $2/\sqrt{6}\text{ sec}$  (d) infinity

**Solution:**

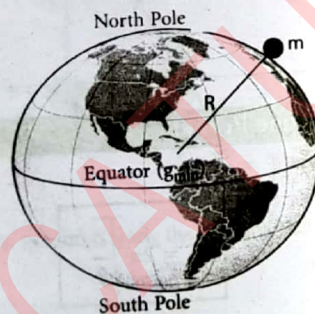
$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T \propto \frac{1}{\sqrt{g}}$$

$$\text{As } g' = \frac{g}{6} \Rightarrow T' = \sqrt{6} T = 2\sqrt{6} \text{ s}$$

اگر pendulum کو کسی ایسی جگہ shift کیا جائے جہاں 'g' کی دیکھ کر مختلف ہو تو اس pendulum کا ٹیڑھا  
 بھی change ہو جائے گا

**VARIATION IN VALUE OF 'g'****On surface of earth**

- Expression for 'g' on the surface of earth is  $g = \frac{GM}{R^2}$
- At poles value of  $g$  is maximum due to shorter distance from center of earth and value of  $g$  is independent of rotation of earth.
- At equator value of  $g$  is maximum due to longer distance from center of earth and due to rotation of earth. (value of  $g$  varies inversely with rotation of earth. If angular velocity of earth increases value of  $g$  decreases and vice versa).
- By moving from poles to equator value of 'g' decreases.
- By moving from equator to pole value of 'g' increases.

**1. Above the surface of earth:**

- At height  $h$  value of 'g' is given as

$$g' = \frac{GM}{(R+h)^2}$$

- By increasing the height value of 'g' decreases.

$$g_{\text{karachi}} > g_{\text{murree}} > g_{(K-2)}$$



Height	$h = \frac{R}{2}$	$h = R$	$h = 2R$	$h = 3R$
$g$	$g' = \frac{4g}{9}$	$g' = \frac{g}{4}$	$g' = \frac{g}{9}$	$g' = \frac{g}{16}$

**2. In depth of earth:**

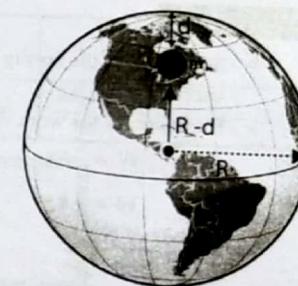
- At depth 'd' value of 'g' is given as

$$g' = \frac{GM(R-d)}{R^3}$$

- By increasing depth value of 'g' decreases.

**Example:** If  $d = \frac{R}{2}$

$$g' = \frac{GM(R - \frac{R}{2})}{R^3} = \frac{GM(\frac{R}{2})}{R^3} = \frac{GM}{2R^2} = \frac{g}{2}$$





**3. Value of 'g' is zero in four cases:**

- At center of the planets.
- At infinite distance from the planet.
- Inside satellites revolving around the earth.
- Inside a freely falling system.

(At these places time period of pendulum is infinity and frequency will be zero)

**4. In an accelerating frame of reference**

- If it is moving upward with acceleration 'a' then  $g' = g + a$  ( $g$  increases).
- If it is moving downward with acceleration 'a' then  $g' = g - a$  ( $g$  decreases).
- If it is at rest or moving with uniform velocity ( $a = 0$ ) then  $g' = g$ .
- If it is moving in horizontal direction with acceleration  $a$  then  $g' = \sqrt{g^2 + a^2}$  ( $g$  increases)

Elevator moving with uniform velocity $v(a=0)$	Elevator moving with upward acceleration $a$	Elevator moving with downward acceleration $a=g$	Elevator is falling freely $a=g$
			
$g' = g$	$g' = g + a$	$g' = g - a$	$g' = 0$

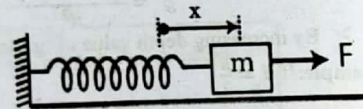
## ENERGY CONVERSION IN SHM

- If a body is executing SHM then P.E and K.E interchanges into each other but total amount of energy always remains constant.

## Work done:

- In stretching the spring work is done by variable force.  
➤ Expressions for work done.

- $W = \frac{1}{2}Fx$
- $W = \frac{1}{2}kx^2$
- $W = \frac{F^2}{2k}$



expression کے ساتھ معلوماتی سوالات

اس سے فیصلہ

## Example 1:

If two different springs are subjected to same amount of force and the ratio between their extensions is 1:2 then the ratio between the work done will be.

- (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1

## Example 2:

To produce 2cm extension in the spring 5J work is done on it. How much work is required to produce 4cm extension?

- (a) 5J (b) 10J (c) 20J (d) 40J

## Solution:

$$\Rightarrow W \propto x \quad (F = \text{constant})$$

So ratio between work is 1:2

## Solution:

$$W = \frac{1}{2}kx^2 \Rightarrow W \propto x^2 \quad (k = \text{constant})$$

Since extension is doubled so work becomes 4 times  $W = 4(5) = 20J$

## Example 3:

If 2N force is applied on a spring having spring constant  $10Nm^{-1}$  then work done is equal to.

- (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1

## Potential Energy:

- Since elastic force is conservative force so work done is equal to gain in P.E.

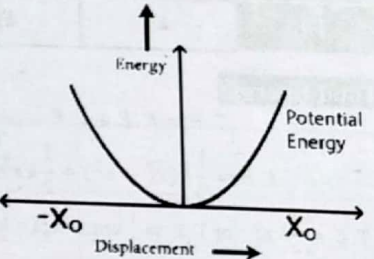
$$P.E = \frac{1}{2}Fx, \quad P.E = \frac{1}{2}kx^2, \quad P.E = \frac{F^2}{2k}$$

- At mean position  $x = 0$

$$P.E = 0 \quad (\text{minimum})$$

- At extreme position  $x = x_0$

$$P.E = \frac{1}{2}kx_0^2 \quad (\text{maximum})$$



Displacement	$x = 0$	$\frac{x_0}{2}$	$\frac{x_0}{\sqrt{2}}$	$\frac{\sqrt{3}x_0}{2}$	$x_0$
P.E	0	$\frac{E_0}{4} = 25\%$	$\frac{E_0}{2} = 50\%$	$\frac{3E_0}{4} = 75\%$	$E_0 = 100\%$

## Note:

P.E of horizontal mass-spring system is independent of mass of the body.

## Kinetic Energy:

As  $K.E = \frac{1}{2}mv^2$  and  $v = \sqrt{\frac{k}{m}}\sqrt{x_0^2 - x^2}$

$$\Rightarrow K.E = \frac{1}{2}k(x_0^2 - x^2) \quad \text{or}$$

$$K.E = \frac{1}{2}m\omega^2(x_0^2 - x^2) \quad (\because k = m\omega^2)$$

- K.E depends upon spring constant amplitude and displacement.

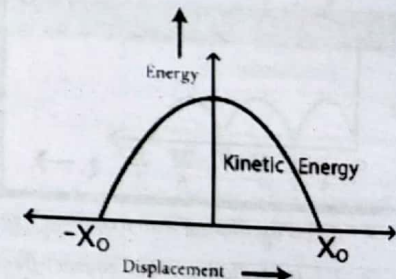
- K.E is independent of mass of the body.

- At mean position  $x = 0 \Rightarrow$

$$K.E = \frac{1}{2}kx_0^2 \quad (\text{maximum})$$

- At extreme position  $x = x_0 \Rightarrow$

$$K.E = 0 \quad (\text{minimum})$$



Displacement	$x = 0$	$x = \frac{x_0}{2}$	$x = \frac{x_0}{\sqrt{2}}$	$x = \frac{\sqrt{3}x_0}{2}$	$x_0$
P.E	0	$\frac{E_0}{4} = 25\%$	$\frac{E_0}{2} = 50\%$	$\frac{3E_0}{4} = 75\%$	$E_0 = 100\%$
K.E	$E_0 = 100\%$	$\frac{3E_0}{4} = 75\%$	$\frac{E_0}{2} = 50\%$	$\frac{E_0}{4} = 25\%$	0
T.E	$E_0$	$E_0$	$E_0$	$E_0$	$E_0$

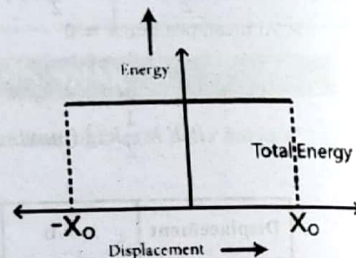
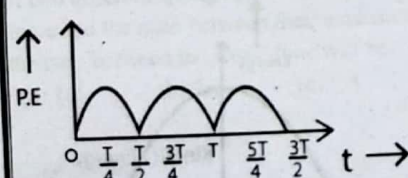
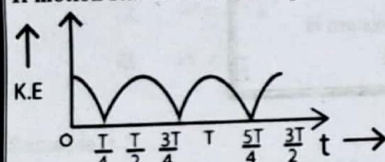
**Total Energy:**

$$T.E = K.E + P.E$$

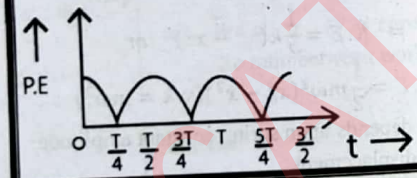
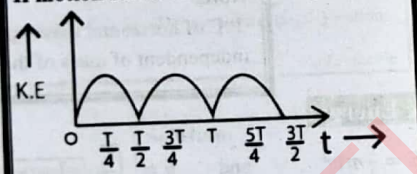
$$T.E = \frac{1}{2}k(x_0^2 - x^2) + \frac{1}{2}kx^2$$

$$T.E = \frac{1}{2}kx_0^2 \text{ or } T.E = \frac{1}{2}km\omega^2x_0^2 (\because k = m\omega^2)$$

- T.E only depends upon spring constant and amplitude.
- T.E is directly proportional to square of amplitude ( $T.E \propto x_0^2$ )
- T.E of mass spring system is independent of displacement and mass of the body.

**If motion starts from mean position**

- K.E is oscillating with frequency  $2f$  and time period  $\frac{T}{2}$
- P.E is oscillating with frequency  $2f$  and time period  $\frac{T}{2}$

**If motion starts from extreme position****Example:**

At what displacement P.E and K.E of a body executing SHM are equal.

(a)  $\frac{x_0}{2}$  (b)  $\frac{x_0}{\sqrt{2}}$  (c)  $\frac{\sqrt{3}x_0}{2}$  (d)  $x_0$

**Solution:** P.E = K.E

$$\frac{1}{2}kx^2 = \frac{1}{2}k(x_0^2 - x^2)$$

$$x^2 = x_0^2 - x^2$$

$$2x^2 = x_0^2$$

$$x = \frac{x_0}{\sqrt{2}}$$

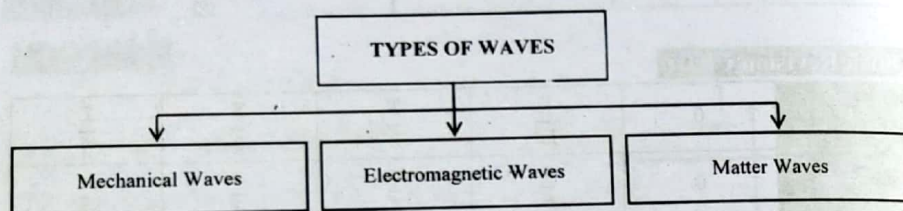
**Quick Revision Chart:**

t	0	$\frac{T}{12}$	$\frac{T}{8}$	$\frac{T}{6}$	$\frac{T}{4}$
$\theta$	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
x	0	$x = \frac{x_0}{2}$	$x = \frac{x_0}{\sqrt{2}}$	$x = \frac{\sqrt{3}x_0}{2}$	$x_0$
v	$v_0 = x_0\omega$	$\frac{\sqrt{3}v_0}{2}$	$\frac{v_0}{\sqrt{2}}$	$\frac{v_0}{2}$	0
A	0	$\frac{a_0}{2}$	$\frac{a_0}{\sqrt{2}}$	$\frac{\sqrt{3}a_0}{2}$	$a_0 = x_0\omega^2$
P.E	0	$\frac{E_0}{4}$	$\frac{E_0}{2}$	$\frac{3E_0}{4}$	$E_0 = \frac{1}{2}kx_0^2$
K.E	0	$\frac{3E_0}{4}$	$\frac{E_0}{2}$	$\frac{E_0}{4}$	0

Quantity	At mean Position	At Extreme Position
Displacement	0	$x_0$ (maximum)
Velocity	$x_0\omega$ (maximum)	0
Acceleration	0	$x_0\omega^2$ (maximum)
Force	0	$kx_0 = mx_0\omega^2$ (maximum)
Momentum	$mx_0\omega$ (maximum)	0
P.E	0	$\frac{1}{2}kx_0^2$ (maximum)
K.E	$\frac{1}{2}kx_0^2$ (maximum)	0

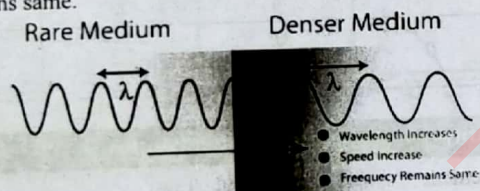
## WAVES

- Wave is disturbance in a medium which transfers energy and momentum from one region of space to another.
- Wave do not transfers matter.

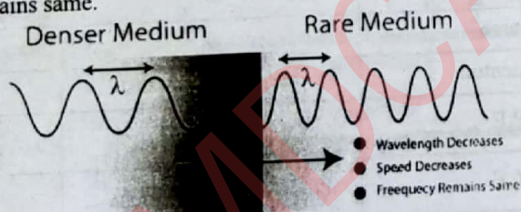


## Mechanical Waves:

- They require medium for their propagation.
- They are produced by vibrating matter particles.
- Water waves, waves in spring, waves in string, sound waves, ultrasound waves and infrasound waves are mechanical waves.
- In vacuum speed of mechanical waves is zero.
- When enter from rare to denser medium their speed and wavelength both increases but frequency remains same.



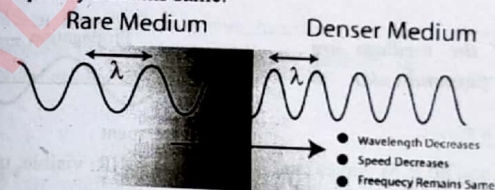
- When enter from denser to rare medium their speed and wavelength both decreases but frequency remains same.



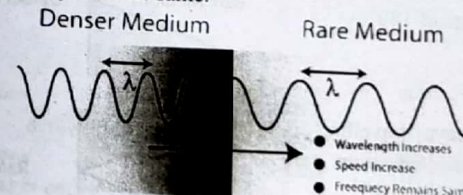
Wave:	Electromagnetic Waves:
Sound waves	20Hz—20000Hz
Infrasound	Less than 20Hz
Ultrasound	Greater than 20000Hz

## Electromagnetic Waves:

- **They do not require medium for their propagation.**
- Vibrating electric and magnetic field in perpendicular direction.
- Radio waves, micro waves, infrared, visible light, ultraviolet, x-rays and  $\gamma$ -rays are electromagnetic waves.
- **Spectrum**
- **Visible light spectrum.**
- In vacuum all electromagnetic waves have same speed =  $3 \times 10^8 \text{ m/s}$ .
- Relation between wavelength and frequency is  $f \propto \frac{1}{\lambda}$ .
- When enter from rare to denser medium their speed and wavelength both decreases but frequency remains same.



- When enter from denser to rare medium their speed and wavelength both increases but frequency remains same.



In medium  
 $v \propto \lambda$

**Example:**

Which of following radiation will travel faster in glass  
(A) Infrared

- (A) Infrared (B) Visible light  
(C) Ultraviolet (D) All have same speed

**Answer:** *Infrared*

**Reason:**  
Infrared have greater wavelength than others so  $\nu \propto \lambda$

**Matter Waves:**

- Waves associated with moving particles.
- Matter waves were proposed by De-Broglie.
- For example De-Broglie wavelength of a particle is given as

In terms of speed	In terms of momentum	In terms of energy	In terms of accelerating voltage
$\lambda = \frac{h}{mv}$	$\lambda = \frac{h}{p}$	$\lambda = \frac{h}{\sqrt{2mE}}$	$\lambda = \frac{h}{\sqrt{2meV}}$
$\lambda \propto \frac{1}{m}$ and $\lambda \propto \frac{1}{v}$	$\lambda \propto \frac{1}{p}$	$\lambda \propto \frac{1}{\sqrt{E}}$	$\lambda \propto \frac{1}{\sqrt{V}}$

**PROGRESSIVE OR TRAVELLING WAVES**

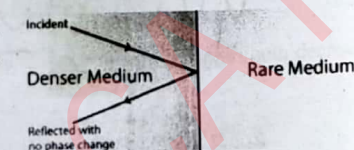
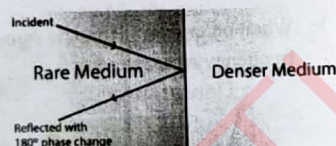
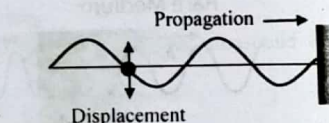
- Waves which transfer energy by moving away from source of disturbance are called **progressive waves**.
- Transverse and longitudinal waves are two types of progressive waves.

**Transverse Waves:**

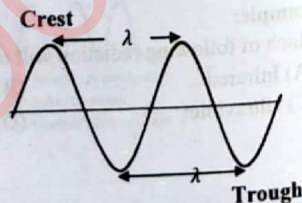
Waves in which particles of the medium are displaced in a direction perpendicular to direction of propagation.

- Water waves, waves in string and all E.M waves (radio, microwaves, IR, visible, ultraviolet, x-rays,  $\gamma$ -rays) are transverse waves

- When a transverse wave travelling in rare medium is reflected from denser medium it undergo a phase change of  $180^\circ$ .



- When a transverse wave travelling in denser medium is reflected from rare medium no phase change occurs.

**Crest:**

Portion of wave in which particles are displaced above their mean position.

**Trough:**

Portion of wave in which particles are displaced below their mean position.

**Wavelength:**

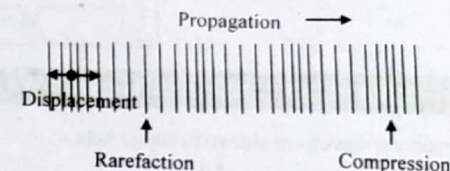
Distance between two consecutive crests or troughs is called wavelength.

- Transverse waves can be polarized.
- Transverse waves can be set up only in solids, in liquids and gases they are damped out quickly.

**Longitudinal Waves:**

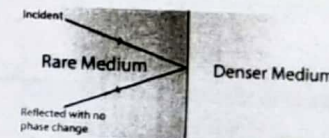
Waves in which particles of the medium are displaced in a direction along the direction of propagation of waves.

- Sound waves, ultrasound waves, infrasound waves and waves in spring are examples of longitudinal waves.

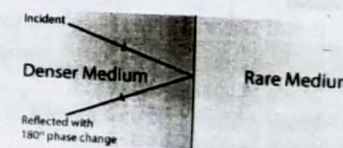


- **Compression:** Portion of the wave in which density of particles is high.
- **Rarefaction:** Portion of the wave in which density of particles is low.

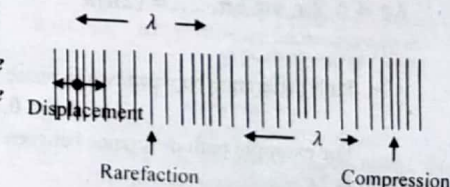
- When longitudinal waves travelling in rare medium is reflected from denser medium, no phase change occurs.



- When longitudinal wave travelling in denser medium is reflected from rare medium it undergoes a phase change of  $180^\circ$ .

**Wavelength:**

Distance between two consecutive compressions or two consecutive rarefactions is called wavelength.



- Longitudinal waves can not be polarized.
- Longitudinal waves can be set up in all type of media solids, liquids and gases.

پاور گیج  
Longitudinal و Transverse ویوز میں فرق صرف Polarization کی base پر کرتے ہیں

**PERIODIC WAVES:**

Continuous, regular and rhythmic disturbances in a medium are called periodic waves.

- Relation  $v = f\lambda$  is only applicable for periodic waves.

**Speed:** Distance covered by wave in one second.

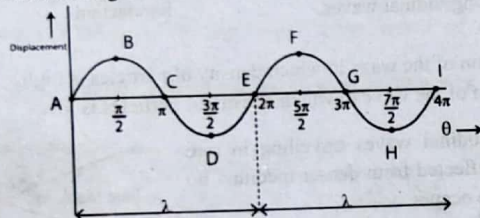
**Wavelength:** Distance between two consecutive points which are in phase.

**Frequency:** Number of waves passing through a point in one second.

$$f = \frac{\text{number of waves}}{\text{time}}$$

**PHASE RELATIONSHIP BETWEEN TWO POINTS ON A WAVE**

Consider a waveform shown in figure below

**In phase:**

- Points having same displacements as well as same direction of motion are called in phase points.
- Phase difference between two in phase points is even  $\pi$

$$\Delta\phi = 0, 2\pi, 4\pi, 6\pi, \dots = (2n)\pi$$

- Path difference between two in phase points is integral multiple of  $\lambda$

$$\Delta x = 0, \lambda, 2\lambda, 3\lambda, \dots = n\lambda$$

For example path difference between A and E is  $\lambda$  and path difference between A and I is  $2\lambda$

**Examples:**

- Points A, E and I are in phase.
- Points B and F are in phase.
- Points D and H are in phase.
- Points C and G are in phase.

یاد رکھیں

Phase difference سے مراد Angle میں فرق ہے مثال کے طور پر C اور G پوائنٹ کے angle میں فرق  $2\pi$  ہے

**Out of phase:**

- Points having opposite displacement or opposite direction of motion are called out of phase points.

- Phase difference between two out of phase points is odd  $\pi$

$$\Delta\phi = 0, 2\pi, 4\pi, 6\pi, \dots = (2n+1)\pi$$

**Example:** Phase difference between B and D =  $\frac{3\pi}{2} - \frac{\pi}{2} = \pi$

- Path difference between two out of phase points is integral multiple of  $\frac{\lambda}{2}$

$$\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}, \dots = (2n+1)\frac{\lambda}{2}$$

For example path difference between A and C =  $\frac{\lambda}{2}$ .

**Examples:**

- Points A and C are out of phase.
- Points B and D are out of phase.

Relation between phase difference and path difference is given as

$$\Delta\phi = \frac{2\pi(\Delta x)}{\lambda}$$

اگر  $\Delta x$  یا  $\Delta\phi$  دونوں میں سے کوئی ایک معلوم ہو تو دوسرے کو معلوم کریں۔

**Example:**

Path difference between two points is  $\frac{3\lambda}{4}$  then the points are:

- (a) In phase
- (b) Out of Phase
- (c) Coherent
- (d) Neither in phase nor out of phase

**Answer:**

neither in phase nor out of phase

Because Path difference is neither multiple of  $\lambda$  nor  $\frac{\lambda}{2}$ .

**SPEED OF SOUND**

- Sound waves (pressure waves) are longitudinal waves.
- In vacuum (free space) speed of sound is zero.
- In any medium speed of sound is given as

$$v = \sqrt{\frac{E}{\rho}}$$

**Speed of sound only depends upon two factors**

- i. Modulus of elasticity of the medium or compressibility of medium.

$$v \propto \sqrt{E} \quad \text{or} \quad v \propto \frac{1}{\sqrt{\text{compressibility}}}$$

( $\because E = \frac{1}{\text{compressibility}}$ )

- ii. Density or inertia of the medium.
- iii. Speed of sound is independent of frequency, wavelength or loudness.

- iv. In solids molecules are closely spaced to each other as compared to liquids and gases that is why they respond to the disturbance more quickly as

$$\text{OR} \quad E_s > E_{liq} > E_g \quad \text{So} \quad v_s > v_{liq} > v_g$$

**Example:** Which of the following sound waves have greater speed in air

- (a) 20 Hz
- (b) 10,000 Hz
- (c) 20,000 Hz
- (d) All have same  $\checkmark$

## SPEED OF SOUND IN AIR

## Newton's Calculations:

For calculating speed of sound in air Newton assumed that when sound waves passes through air temperature of air remains constant (isothermal process).

- Boyle's law is applicable ( $PV = \text{constant}$ ).
- According to Newton or for isothermal process, modulus of elasticity of air is equal to pressure of air ( $E = P = 1.01 \times 10^5 \text{ pa}$ )
- According to Newton speed of sound in air is

$$v = \sqrt{\frac{P}{\rho}} \quad (\because E = P)$$

$$v = \sqrt{\frac{1.01 \times 10^5}{1.29}} = 280 \text{ m/s}$$

- Experimental value of speed of sound in air at standard temperature ( $0^\circ\text{C}$ ) is 332 m/s.
- There was about 16% error in Newton's calculations.

## Laplace Correction:

- Laplace pointed out that compressions and rarefactions occurs so rapidly that heat produced during the compressions is confined to the region where it is generated and does not have time to flow to the cooler region where rarefaction occurs.
- Temperature of air does not remain constant.
- Since no heat flow occurs so passage of sound is an adiabatic process.
- Relation between pressure and volume is  $PV^\gamma = \text{constant}$ .
- $\gamma = \frac{C_p}{C_v} = \frac{\text{molar specific heat at constant pressure}}{\text{molar specific heat at constant volume}}$
- $\gamma$  has no unit, no dimensions and  $\gamma > 1$ .

Monoatomic gas	Diatomic gas	Polyatomic gas
$\gamma = 1.67$	$\gamma = 1.4$	$\gamma = 1.29$

- As air is almost diatomic so for air  $\gamma = 1.4$ .
- According to Laplace or for adiabatic process, modulus of elasticity of air is  $\gamma$  times pressure of air ( $E = \gamma p$ )
- According to Laplace, speed of sound in air is

$$v = \sqrt{\frac{\gamma P}{\rho}} \quad (\because E = \gamma P)$$

$$v = \frac{1.4 \times 1.01 \times 10^5}{1.29} \approx 333 \text{ m/s}$$

## Example:

If  $v_1$  and  $v_2$  are speeds of sound in air according to Newton and Laplace calculations then which of the following is true.

- (a)  $v_1 = v_2$  (b)  $v_1 = \sqrt{\gamma} v_2$  (c)  $v_2 = \sqrt{\gamma} v_1$  (d)  $v_2 = \gamma v_1$

## Solution:

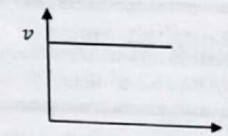
$$\frac{v_1}{v_2} = \frac{\sqrt{\frac{P}{\rho}}}{\sqrt{\frac{\gamma P}{\rho}}} = \frac{1}{\sqrt{\gamma}}$$

$$\Rightarrow v_2 = \sqrt{\gamma} v_1$$

## Effect of Pressure:

Since density is directly proportional the pressure ( $\frac{P}{\rho} = \text{constant}$ ) hence speed of sound is not effected by variation in pressure of air.

- Graph between speed of sound in air verses pressure is straight line



**Example:** If pressure of air is doubled then speed of sound in air will

- (a) Become double (b) Become  $\sqrt{2}$  times (c) Become half (d) Remain same ✓

## Effect of density:

- At constant pressure and temperature speed of sound in air is inversely proportional to root of density.

$$v \propto \frac{1}{\sqrt{\rho}} \quad \text{OR} \quad \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}}$$

- Since ratio between densities of  $\text{O}_2$  to  $\text{H}_2$  is 16 : 1 hence ratio between speed of sound in  $\text{O}_2$  to  $\text{H}_2$  will be 1 : 4.
- $\frac{v_{\text{O}_2}}{v_{\text{H}_2}} = \frac{1}{4}$  OR  $\frac{v_{\text{H}_2}}{v_{\text{O}_2}} = \frac{4}{1}$  OR  $v_{\text{H}_2} = 4v_{\text{O}_2}$

## Example:

At same temperature and pressure in which of following gas speed of sound will be minimum

- (a)  $\text{H}_2$  ✓ (b)  $\text{O}_2$  (c)  $\text{N}_2$  (d) None of these

## Solution:

$\text{H}_2$  lowest density and

$$v \propto \frac{1}{\sqrt{\rho}}$$

## Effect of Temperature:

- At constant pressure and temperature speed of sound increases by increasing temperature.

**Reason:** By increasing temperature, volume increases and density decreases so speed of sound increases.

- At any temperature  $t^\circ\text{C}$  the volume of gas is given as  $V_t = V_0 (1 + \beta t)$

Where  $\beta$  is coefficient of volume expansion and  $\beta = \frac{1}{273}$

$$V_t = V_0 \left( 1 + \frac{t}{273} \right)$$

- Speed of sound in air is directly proportional to square root of absolute temperature (Temperature in Kelvin)

$$v \propto \sqrt{T} \quad \text{OR} \quad \frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} \quad \text{OR} \quad T \propto v^2$$

**Example:**

At what temperature speed of sound will become double as that is at 10°C

- (a) 40 °C                      (b) 313 °C  
(c) 895 °C                    (d) 1132 °C

**Solution:**  $v \propto \sqrt{T}$  or  $T \propto v^2$

If  $v$  is doubled, Temperature should be 4-times

$$T = 4(10 + 273) = 4(283) = 1132K = 1132 - 273 = 895^\circ\text{C}$$

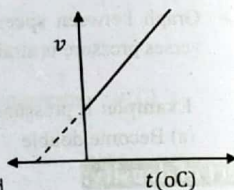
**Note**

If speed becomes  $n$ -times then absolute temperature will become  $n^2$  times ( $T' = n^2 T$ )

- Speed of sound at any temperature  $t(^{\circ}\text{C})$  is given as

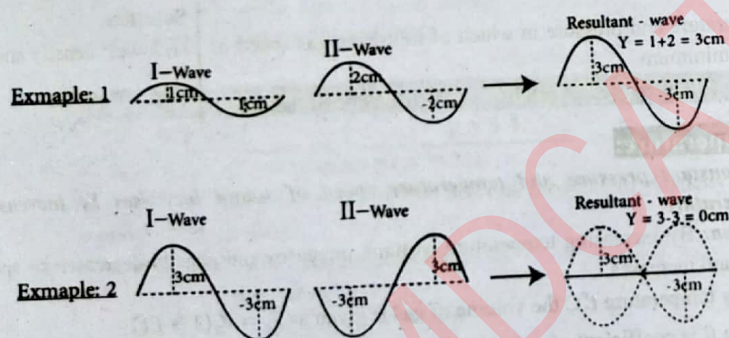
$$v_t = v_0 + 0.61t \quad \text{if } t \ll 273$$

- With one degree or one Kelvin rise in temperature speed of sound increases by 0.61 m/s or 61 cm/s.

**PRINCIPLE OF SUPERPOSITION**

- If two or more waves are simultaneously acted on medium particle then resultant displacement of particle is algebraic sum of their individual displacements.

$$Y = Y_1 + Y_2 + \dots + Y_n$$

**Three cases of Principle of Superposition**

- **Interference:** When two waves of same frequency and travelling in same direction superpose with each other.
- **Beats:** When two waves of slightly different frequencies but travelling in same direction superpose with each other.
- **Stationary:** When two waves of same frequency but travelling in opposite direction superpose with each other.

**INTERFERENCE**

- Superposition of two waves of same frequency and travelling in same direction results a phenomenon called interference.

**Constructive Interference:**

Constructive interference occurs if waves are in phase and they reinforce the effect of each other.

- Phase difference = even  $\pi = (2n)\pi$
- Path difference =  $n\lambda$  (integral multiple of  $\lambda$ ).
- If  $A_1$  and  $A_2$  are amplitude of two waves then resultant amplitude will be  $A_1 + A_2$ .
- Relation between intensity and amplitude is  $\text{intensity} \propto (\text{amplitude})^2$

**Note**

Waves having constant phase difference are called coherent waves.

**Destructive Interference:**

Destructive interference occurs if waves are out of phase and they cancel out the effect of each other.

- Phase difference = odd  $\pi = (2n + 1)\pi$
- Path difference =  $(2n + 1)\frac{\lambda}{2}$  (odd integral multiple of  $\frac{\lambda}{2}$ ).
- Resultant amplitude will be  $A_1 - A_2$ .

**یاد رکھیں**

$(2n + 1)$  ایک odd نمبر کو ظاہر کرتا ہے آپ  $n$  جو ماضی integer درج کریں جواب ہمیشہ odd ہی آئے گا

**Example 1:**

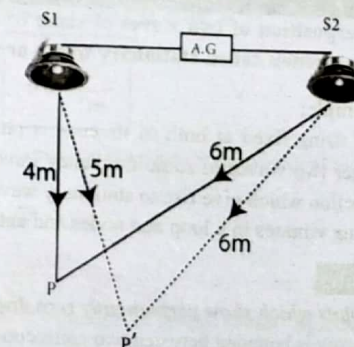
If two speakers are producing sound waves of wavelength  $2m (\lambda = 2m)$  as shown in figure.

If two waves have same amplitude then find resultant displacement at point P and P'.

At point P path difference between two waves is

$$\Delta S = 6m - 2m = 4m = 2(2m) = 2\lambda \quad (\because \lambda = 2m)$$

Since path difference is  $2\lambda$  hence 2<sup>nd</sup> order maxima occur at point P.



Resultant displacement =  $A + A = 2A$

At point P' path difference between two waves is

$$\Delta S = 6\text{m} - 5\text{m} = 1\text{m} = \frac{\lambda}{2} (\because \lambda = 2\text{m})$$

Since path difference is  $\frac{\lambda}{2}$  hence 1<sup>st</sup> order maxima occur at point P.

Resultant displacement =  $A - A = 0$

## BEATS

- Superposition of two waves having slightly different frequency but travelling in same direction results a phenomenon called beats.
- Beats are periodic fluctuations between maximum and minimum sound.
- A single tuning fork produces sound waves of single frequency say  $f = 32\text{ Hz}$
- By loading some wax or plasticize or prongs of tuning forks its frequency decreases say  $f = 30\text{ Hz}$ .
- If two tuning forks are sounded together beats are produced having beat frequency  $2\text{ Hz} = (32 - 30)$ .
- Beat frequency is always equal to difference between the frequencies.

$$f_{\text{beat}} = f_A - f_B$$

**Example:** If two sound waves of frequencies 50 Hz are travelling in same direction then

$$f_{\text{beat}} = 54 - 50 = 4\text{ Hz}$$

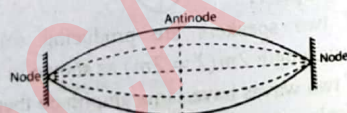
- If beat frequency (number of beats per second) is greater than 10 Hz. Beats can not be distinguished by human ear.
- Beats are useful in tuning a string instruments.

## STATIONARY WAVES

Superposition of two waves of same frequency but travelling in opposite direction results a phenomenon called stationary waves or standing waves.

**Example:**

If a string fixed at both of its ends is plucked from its center two waves of same frequency travels in opposite direction which give rise to stationary waves. String vibrates in a loop and nodes and anti-nodes are formed.

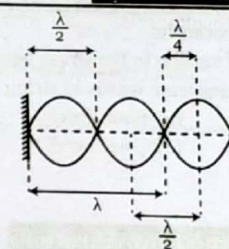


**Nodes:**

Points which show permanently zero displacement are called nodes. Energy is bounded between two consecutive nodes.

**Anti-Nodes:** Points which vibrating with maximum amplitude are called anti-nodes.

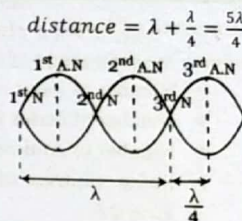
- All the particles of string execute SHM except nodes.
- Distance between two consecutive nodes is  $\frac{\lambda}{2}$ .
- Distance between node and next anti-node is  $\frac{\lambda}{4}$ .
- Distance between two consecutive antinodes is  $\frac{\lambda}{2}$ .



**Example:**

Consider string is vibrating in three loops. What is distance between first node and third anti-node.

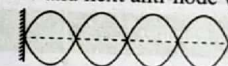
- (a)  $\frac{\lambda}{4}$  (b)  $\frac{3\lambda}{2}$  (c)  $\frac{3\lambda}{4}$  (d)  $\frac{5\lambda}{4}$  ✓



**Example:**

If 12cm string is vibrating in four segments (loops) then distance between node and next anti-node will be

- (a) 0.75cm (b) 1.5cm (c) 3cm (d) 6cm



**Solution:**  $L = 4 \left( \frac{\lambda}{2} \right)$   
 $4 \left( \frac{\lambda}{2} \right) = 12\text{cm}$   
 $\lambda = 6\text{cm}$  thus  
 $\left( \frac{\lambda}{4} \right) = 1.5\text{cm}$

## STATIONARY WAVES IN STRETCHED STRING

- Waves travelling in stretched string are transverse waves.
- If a stretched string is plucked two transverse waves travelling in opposite direction give rise to stationary waves.

**Speed of Waves:** Speed of transverse waves in a stretched string is given as

- $F$  is tension in the string
- $m$  is mass per unit length of string
- Unit of  $m$  is  $\text{kgm}^{-1}$

$$v = \sqrt{\frac{F}{m}}$$

- Speed is directly proportional to square root of tension and inversely proportional to square root of mass per unit length of string.

$$v \propto \sqrt{F}$$

$$v \propto \frac{1}{\sqrt{m}}$$

- Speed of waves in stretched string is independent of length of string, number of loops and frequency of vibration.

**Example:**

If tension in the string becomes four times than speed of transverse waves in string will become

- (a) Four times  
(b) Two times  
(c) One fourth  
(d) One half

**Solution:**

$$\text{As } v \propto \sqrt{F}$$

So, speed will become two times

$$\text{If } v \propto \sqrt{F} \text{ then } v \propto \sqrt{4F} = 2\sqrt{F}$$

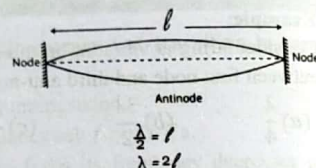
$$v = 2v_0$$

**I-mode of vibration:**

If a string of length  $\ell$  is plucked from length  $\frac{\ell}{2}$  it will vibrate in single loop.

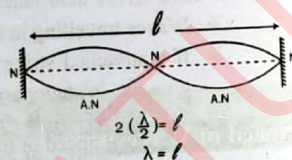
- Number of loops formed = 1
- Number of nodes formed = 2
- Number of Anti-nodes formed = 1
- String vibrates with maximum wavelength i.e.  $\lambda_1 = 2\ell$
- String vibrates with minimum frequency i.e.  $f_1 = \frac{1}{2\ell} \sqrt{\frac{F}{m}}$
- $f_1$  is known as fundamental frequency, fundamental tone or I-harmonic.

Law of length	Law of tension	Law of mass
$f \propto \frac{1}{\ell}$	$f \propto \sqrt{F}$	$f \propto \frac{1}{\sqrt{m}}$

**II mode of vibration:**

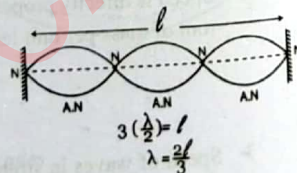
If a string is plucked from length  $\frac{\ell}{4}$  it vibrates in two loops.

- Number of loops formed = 2
- Number of nodes formed = 3
- Number of Anti-nodes formed = 2
- String vibrates with wavelength i.e.  $\lambda_2 = \frac{\ell}{2} = \ell$
- String vibrates with frequency  $f_2 = 2f_1$

**III mode of vibration:**

If a string is plucked from length  $\frac{\ell}{6}$  it vibrates in two loops.

- Number of loops formed = 3
- Number of nodes formed = 4
- Number of Anti-nodes formed = 3
- String vibrates with wavelength i.e.  $\lambda_3 = \frac{\ell}{3} = \frac{2\ell}{3}$
- String vibrates with frequency  $f_3 = 3f_1$

**Harmonics:**

Such oscillations in which each frequency is integral multiple of fundamental frequency are called harmonics.

- Only harmonics are produced in stretched string having frequencies  $f_1, 2f_1, 3f_1, 4f_1, \dots$  and wavelength  $\lambda_1, \frac{\lambda_1}{2}, \frac{\lambda_1}{3}, \frac{\lambda_1}{4}, \dots$
- Frequencies other than harmonics are damped out quickly.

**Example:**

If fundamental frequency is 20Hz then which of the following frequency waves can not be produced in stretched string.

- (a) 40 Hz  
(b) 60 Hz  
(c) 70 Hz  
(d) 80 Hz

**Solution:**

70 Hz is not integral multiple of 20 Hz.

**nth-Harmonic:**

- String is plucked from  $= \frac{\ell}{2n}$
- Number of loops formed = n
- Number of nodes formed = n + 1
- Number of antinodes formed = n

**Frequency:**

$$f_n = n f_1 \quad \text{OR} \quad f_1 = \frac{1}{2\ell} \sqrt{\frac{F}{m}}$$

Where  $n = 1, 2, 3, \dots$

**Wavelength:**

$$\lambda_n = \frac{\lambda_1}{n}$$

OR

$$\lambda_n = \frac{2\ell}{n}$$

Where  $n = 1, 2, 3, \dots$

**Over Tones:**

An overtone is any frequency among harmonic series that is greater than fundamental frequency.

- Examples:
- Frequency of 1<sup>st</sup> overtone =  $2f_1$
  - Frequency of 2<sup>nd</sup> overtone =  $3f_1$
  - Frequency of 3<sup>rd</sup> overtone =  $4f_1$

Frequency	$f_1$	$2f_1$	$3f_1$	$4f_1$	$5f_1$
Mode of vibration	First	Second	Third	Fourth	Fifth
Harmonic	First	Second	Third	Fourth	Fifth
Over tone	Fundamental tone	First	Second	Third	Fourth

## APPLICATIONS

- Nuts on guitar are used to change the tension in string and thus change the frequency.
- String of different mass per unit length are used to produce note of different frequencies.
- One can move hand on the neck of guitar to change the length of string to produce note of different frequencies.

**Example:**

If frequency of 5<sup>th</sup> over tone is 60 Hz then frequency 2<sup>nd</sup> harmonic will be

- (a) 10 HZ (b) 20 HZ (c) 25 HZ (d) 30 HZ

**Example:**

If three consecutive frequencies of a harmonic series given as 60 Hz, 75 Hz, 90 Hz then frequency of 1<sup>st</sup> overtone will be

- (a) 5 HZ (b) 15 HZ (c) 30 HZ (d) 60 HZ

**Solution:**

5th over tone =  $6f_1 = 60$

$$\Rightarrow f_1 = 10 \text{ Hz}$$

Frequency 2<sup>nd</sup> harmonic =  $2f_1 = 20 \text{ Hz}$

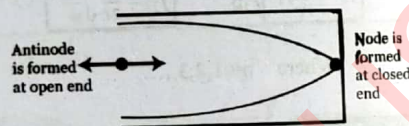
**Solution:**

$$f_1 = 75 - 60 = 15 \text{ Hz}$$

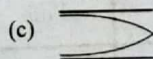
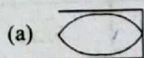
Frequency of 1<sup>st</sup> over tone =  $2f_1 = 2(15) = 30 \text{ Hz}$

## STATIONARY WAVES IN AIR COLUMN

- Longitudinal wave (sound or pressure waves) can produce stationary waves in air column.
- When we blow air in an air column then the relation between incident and reflected wave depends on whether reflecting end is open or closed
- (i) At open end air molecules have complete freedom of motion and can vibrate with maximum displacement and thus it behave as anti node.
- (ii) At closed end motion of air molecules is restricted and displacement of air molecules remains permanently zero thus it behave as node.
- Although sound waves are longitudinal waves but the displacement of air molecules can be represented by a transverse wave.



**Example:** Which of the following mode of vibration can not be produced in air column?



(d) All of these ✓

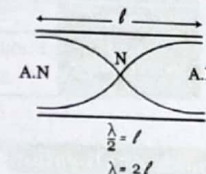
**Reason:** At open end always anti-node and at closed end always node is formed.

## Case-I: Pipe is open at both ends

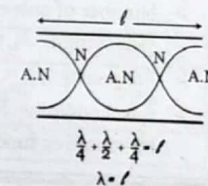
**I-mode of vibration**

Consider a pipe of length  $\ell$  open at both ends.

- Number of loops formed = 1
- Number of nodes formed = 1
- Number of anti-nodes formed = 2
- Wavelength:  $\lambda = 2\ell$  (maximum wavelength)
- Frequency:  $f_1 = \frac{v}{2\ell}$  (Where  $v$  is speed of sound in air)
- $f_1$  is known as fundamental frequency or fundamental harmonic or fundamental tone.

**II-mode of vibration**

- Number of loops formed = 2
- Number of nodes formed = 2
- Number of anti-nodes formed = 3
- Wavelength:  $\lambda = \frac{\lambda_1}{2} \Rightarrow f_2 = \frac{2\ell}{\lambda}$
- Frequency:  $f_2 = 2f_1 \Rightarrow f_2 = \frac{2v}{2\ell}$

**nth-Harmonic:**

- Number of loops formed =  $n$
- Number of nodes formed =  $n$
- Number of antinodes formed =  $n+1$

**Frequency:**

$$f_n = nf_1 \quad \text{OR} \quad f_n = \frac{nv}{2\ell}$$

Where  $n = 1, 2, 3, \dots$

**Wavelength:**

$$\lambda_n = \frac{\lambda_1}{n}$$

OR

$$\lambda_n = \frac{2\ell}{n}$$

Where  $n = 1, 2, 3, \dots$

**Harmonics:**

Such oscillations in which each frequency is integral multiple of fundamental frequency are called harmonics.

- In an open end pipe only harmonic are produced having frequencies  $f_1, 2f_1, 3f_1, 4f_1, \dots$  and wave length  $\lambda_1, \frac{\lambda_1}{2}, \frac{\lambda_1}{3}, \dots$
- Frequencies other than harmonics are damped out quickly.

**Over Tones:**

An overtone is any frequency among the harmonic that is greater than fundamental frequency.

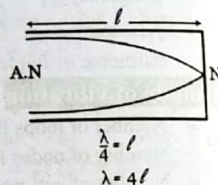
- Examples:**
- Frequency of 1<sup>st</sup> overtone =  $2f_1$
  - Frequency of 2<sup>nd</sup> overtone =  $3f_1$
  - Frequency of 3<sup>rd</sup> overtone =  $4f_1$

Frequency	$f_1$	$2f_1$	$3f_1$	$4f_1$	$5f_1$
Mode of vibration	First	Second	Third	Fourth	Fifth
Harmonic	First	Second	Third	Fourth	Fifth
Over tone	Fundamental tone	First	Second	Third	Fourth

**Case-II: Pipe is open at both ends****I-mode of vibration**

Consider a pipe of length  $\ell$  open at both ends.

- Number of loops formed =  $\frac{1}{2}$
- Number of nodes formed = 1
- Number of anti-nodes formed = 1
- Wavelength:  $\lambda_1 = 4\ell$  (maximum)
- Frequency:  $f_1 = \frac{v}{2\ell}$  (minimum)
- $f_1$  is known as fundamental frequency or fundamental harmonic or fundamental tone.

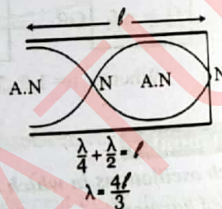


**Note:** Single loop is produced in closed end pipe as shown in the following figures

Because at open end always anti-nodes and at closed end always node is formed. Hence 2<sup>nd</sup> harmonic cannot be produced in closed end pipe.

**II-mode of vibration**

- Number of loops formed =  $\frac{3}{2}$
- Number of nodes formed = 2
- Number of anti-nodes formed = 2
- Wavelength:  $\lambda_3 = \frac{\lambda_1}{3} \Rightarrow \frac{4\ell}{3}$
- Frequency:  $f_3 = 3f_1 \Rightarrow \frac{3v}{4\ell}$

**nth-Harmonic:**

- Number of loops formed =  $\frac{n}{2}$
- Number of nodes formed =  $\frac{n+1}{2}$
- Number of anti-nodes formed =  $\frac{n+1}{2}$

Frequency:

$$f_n = n f_1$$

$$f_n = \frac{nv}{4\ell}$$

Where  $n = 1, 3, 5, \dots$

Wavelength:

$$\lambda_n = \frac{\lambda_1}{n}$$

OR

$$\lambda_n = \frac{4\ell}{n}$$

Where  $n = 1, 3, 5, \dots$

**Harmonics:**

Such oscillations in which each frequency is integral multiple of fundamental frequency are called harmonics.

- If pipe is closed at one end only odd harmonics are produced having frequencies  $f_1, 3f_1, 5f_1, \dots$  and wavelength  $\lambda_1, \frac{\lambda_1}{3}, \frac{\lambda_1}{5}, \dots$
- Frequencies other than odd harmonics are damped out quickly.

**Over Tones:**

An overtone is any frequency among the harmonic series that is greater than fundamental frequency.

- Examples:**
- Frequency of 1<sup>st</sup> overtone =  $3f_1$
  - Frequency of 2<sup>nd</sup> overtone =  $5f_1$
  - Frequency of 3<sup>rd</sup> overtone =  $7f_1$

Frequency	$f_1$	$3f_1$	$5f_1$	$7f_1$	$9f_1$
Mode of vibration	First	Second	Third	Fourth	Fifth
Harmonic	First	3 <sup>rd</sup>	5 <sup>th</sup>	7 <sup>th</sup>	9 <sup>th</sup>
Over tone	Fundamental tone	First	Second	Third	Fourth

**Note:** If pipe is open at both ends, both even and odd harmonics are produced. But if pipe is closed at one end only odd harmonics are produced. So open end pipe is richer in harmonics than closed end pipe.

**DOPPLER'S EFFECT**

Apparent change in frequency of waves due to relative motion between source and observer is called Doppler's effect.

- Doppler's effect was first observed for light coming from a distant star.
- Doppler's effect is applicable for all types of waves (longitudinal or Transverse, mechanical or electromagnetic)

**Case i:**

Frequency میں 'change' دراصل 'change' در فاصلہ اور observer اور source کے درمیان 'change' در فاصلہ کی وجہ سے ہوتا ہے۔

- (Doppler's effect is observed)
- If distance between source and observer decreases then frequency increases.
- If distance between source and observer increases then frequency decreases.
- If distance between source and observer does not change then frequency remains same and  $\Delta f = 0$ .

## Case ii:

Relative speed صرف تب change کی جب observer move کر رہا ہو۔

- If observer is moving towards the source then relative speed increases and  $v_{rel} = v + u_o$  where  $v$  is speed of the wave and  $u_o$  is speed of observer.
- If observer is moving away from source then relative speed of wave decreases and  $v_{rel} = v - u_o$
- If observer is at rest then relative speed of wave does not change.

## Case iii: (Doppler shift is produced only if source is moving)

Wave length میں change صرف تب پیدا ہو گا جب source move کرے گا۔

- If source is moving towards the observer then apparent wavelength decreases and  $\lambda' = \lambda - \Delta\lambda$
- If source is moving away from the source apparent wavelength increases and  $\lambda' = \lambda + \Delta\lambda$
- If source is at rest then wavelength remains same  $\lambda' = \lambda$  and  $\Delta\lambda = 0$

## Doppler's Shift:

Change in wavelength  $\Delta\lambda$  is known as Doppler shift and

$$\Delta\lambda = \frac{u_s}{f}$$

Where  $u_s$  is speed of source and  $f$  is actual frequency  
Doppler's shift only depends upon two factors.

- Speed of source  $\Delta\lambda \propto u_s$
- Actual Frequency  $\Delta\lambda \propto \frac{1}{f}$

## Example:

If two cars A and B horn the sound of same frequency while approaching an observer with velocities 20 m/s and 30 m/s respectively then Doppler shift is maximum for?

- (a) Car A (b) Car B (c) Same for A and B (d) Zero for A and B

## Example:

If a star is moving towards the earth with speed  $v$  then Doppler shift is maximum for?

- (a) IR ✓ (b) uv (c) Visible light (d) same for all E.M waves

Solution:

Car A

Reason:

$$(\Delta\lambda \propto u_s)$$

Solution:

IR

Reason:

$$(\Delta\lambda \propto \frac{1}{f})$$

## Apparent Frequency:

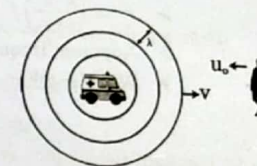
General relation for apparent frequency is given as

$$f' = \frac{v \pm u_o}{v \mp u_s} \times f$$

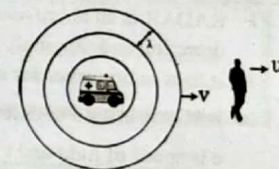
اگر observer قریب آ رہا ہو +ve لگائیں  
 اگر observer دور جا رہا ہو -ve لگائیں  
 اگر source قریب آ رہا ہو +ve لگائیں  
 اگر source دور جا رہا ہو -ve لگائیں

1. If observer is moving towards stationary source ( $u_s = 0$ )

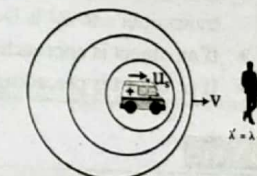
- $f' = \left(\frac{v+u_o}{v}\right) f$
- Apparent frequency increases.
- Pitch of sound increases.
- Wavelength remains same and  $\Delta\lambda = 0$

2. If observer is moving away from stationary source ( $u_s = 0$ )

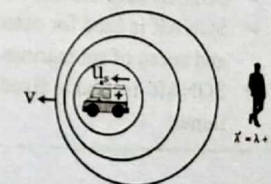
- $f' = \left(\frac{v-u_o}{v}\right) f$
- Apparent frequency decreases.
- Pitch of sound decreases.
- Wavelength remains same and  $\Delta\lambda = 0$

3. If source is moving towards stationary source ( $u_o = 0$ )

- $f' = \left(\frac{v}{v-u_s}\right) f$
- Apparent frequency increases.
- Pitch of sound increases.
- Wavelength remains same and  $\Delta\lambda = \frac{u_s}{f}$

4. If source is moving away from stationary source ( $u_o = 0$ )

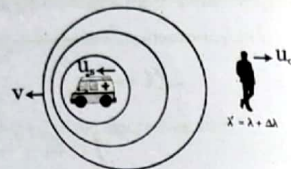
- $f' = \left(\frac{v}{v+u_s}\right) f$
- Apparent frequency decreases ( $f' < f$ ).
- Pitch of sound decreases.



- Wavelength increases ( $\lambda' > \lambda$ ).

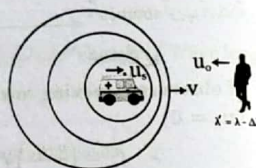
5. If source and observer are moving away from each other.

- $f' = \left( \frac{v+u_o}{v-u_s} \right) f$   
 ➤ Apparent frequency increases ( $f' > f$ ).  
 ➤ Wavelength decreases ( $\lambda' < \lambda$ )



6. If source and observer are moving towards each other.

- $f' = \left( \frac{v-u_o}{v+u_s} \right) f$   
 ➤ Apparent frequency decreases ( $f' < f$ ).  
 ➤ Wavelength increases  $\lambda' > \lambda$



### APPLICATIONS OF DOPPLER'S EFFECTS

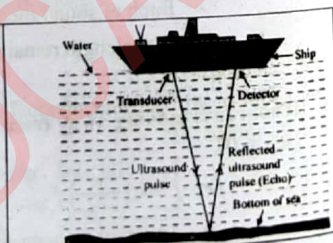
#### RADAR:

- RADAR is an abbreviation of "radio amplification detection and ranging".  
 ➤ It uses radio waves for detection of objects.  
 ➤ RADAR is used to determine the range ( $R = \frac{1}{2}ct$ ) where  $c$  is speed of light and  $t$  is time between transmission and reception of radio signal.  
 ➤ RADAR is used to determine speed of objects ( $u_s = f(\Delta\lambda)$ ) where  $f$  is actual frequency of transmitter and  $\Delta\lambda$  is Doppler's shift.  
 ➤ If an object is approaching the RADAR then  $\lambda$  decreases.  
 ➤ If an object is preceding the RADAR then  $\lambda$  increases.



#### SONAR:

- SONAR is an abbreviation of "sound navigation and ranging".  
 ➤ SONAR uses ultrasound waves.  
 ➤ SONAR is used for detection and to determine range and speed of submarines.  
 ➤ SONAR is used to fixed sea depth and undersea mines.



#### Red Shift:

If a star is moving away from earth its spectrum is shifted towards longer wavelength (towards red) it is known as red shift.

#### Blue Shift:

If star is moving away from earth its spectrum is shifted towards shorter wavelength (blue end) it is known as blue shift.



Light waves are stretched (red-shift)    Light waves are compressed (blue-shift)

#### RADAR Speed Trap:

- RADAR speed trap uses microwaves to determine vehicles speed.  
 ➤ Speed of vehicle can be calculated by ( $u_s = f\Delta\lambda$ ) where  $f$  is actual frequency and  $\Delta\lambda$  is Doppler shift.

#### Do You Know

Ultrasound waves of frequencies 5 MHz to 10 MHz are directed towards artery to monitor blood flow through major arteries apparent frequency depends upon velocity of flow of blood

#### Do You Know

Echolocation allows dolphins to detect small difference in the shape, size and thickness of object.

#### Do You Know

Bat navigates and find food by echo location

## UNIT 05 &gt;&gt;

HEAT AND  
THERMODYNAMICS

**Heat:** Heat is type of energy flowing due to difference in temperature of two bodies.

**Temperature::**

- Macroscopically temperature is measure of hotness or coldness of a body.
- Microscopically temperature is measure of average K.E of molecules of a substance.

## KINETIC MOLECULAR THEORY OF GASES

- There are two evidence for kinetic molecular theory of gases.  
(i) Diffusion (ii) Brownian motion

**Postulates::**

- All gases consists of very small discrete particles called molecules.
- Gas molecules are in state of random motion in all possible directions with different velocities.
- Molecules of gas are constantly colliding with each other and with walls of container.
- Collision of molecules is perfectly elastic collision.
- Molecules of gas do not exert force on each other except collision.
- Volume occupied by gas molecules is negligible as compared to volume of gas. (volume of container).

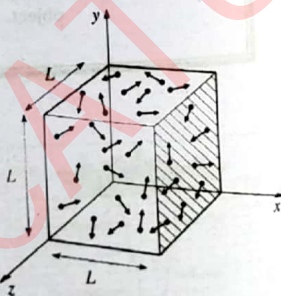
## PRESSURE OF GAS

Pressure of gas is defined as momentum transferred to walls of container per second per unit area due to continuous collisions of gas molecules with the walls of container.

- Consider N number of molecules enclosed in a cubical box of side 'ℓ'.

- If a molecule of mass 'm' moving with velocity  $v_{1x}$  rebounds back with same velocity (due to elastic collision). then

$$\begin{aligned}\text{Change in momentum} &= P_f - P_i = (-mv_1) - (mv_1) \\ &= -2mv_1\end{aligned}$$



- Time between two consecutive collisions  $\Delta t = \frac{2\ell}{v_{1x}}$ .
- No. of collisions per second =  $\frac{v_{1x}}{2\ell}$
- Force exerted by molecule on the wall =  $\frac{\text{change in momentum}}{\text{time}} = \frac{2mv_{1x}}{2\ell}$

$$F_{1x} = \frac{mv_{1x}^2}{\ell}$$

Total force on the wall ABCD =  $F_{1x} + F_{2x} + \dots + F_{Nx}$

$$= \frac{mv_{1x}^2}{\ell} + \frac{mv_{2x}^2}{\ell} + \dots + \frac{mv_{Nx}^2}{\ell}$$

- Pressure on the wall ABCD =  $\frac{m}{\ell^3} (v_{1x}^2 + v_{2x}^2 + \dots + v_{Nx}^2)$

$$P_x = \frac{m\ell}{\ell^3} \left( \frac{v_{1x}^2 + v_{2x}^2 + \dots + v_{Nx}^2}{N} \right)$$

$$P_x = \rho < v_x^2 >$$

- Density of gas =  $\frac{\text{Total mass}}{\text{Total volume}} = \rho = \frac{mN}{\ell^3}$

- Average velocity =  $\frac{v_1 + v_2 + \dots + v_N}{N} = < v > = 0$

- Average square velocity =  $\frac{v_1^2 + v_2^2 + \dots + v_N^2}{N} = < v^2 > \neq 0$

- Root mean square velocity =  $\sqrt{< v^2 >} = \sqrt{\frac{v_1^2 + v_2^2 + \dots + v_N^2}{N}} \neq 0$

- Since molecules are in random motion hence  $< v_x^2 > = < v_y^2 > = < v_z^2 >$

- Similarly  $P_y = \rho < v_y^2 >$  and  $P_z = \rho < v_z^2 >$

- $< v^2 > = < v_x^2 > + < v_y^2 > + < v_z^2 > = 3 < v_x^2 >$

$$\Rightarrow < v_x^2 > = \frac{1}{3} < v^2 > \text{ and } P = \frac{1}{3} \rho < v^2 >$$

- $P_x = P_y = P_z$  (Pascal's law)

- Net pressure on any wall of container is given as

$$P = \rho < v^2 >$$

**Example:** If velocity or speed of each molecule is doubled then pressure of gas will become

- (a) Double (b) Half (c) Four Times (d) Remains same

**Solution:** As  $P \propto < v^2 >$   
If  $v$  is doubled,  $P$  will become four times.

**Example:**

If average square velocity of gas molecules is doubled, pressure of gas will become

- (a) Double ✓ (b) Half (c) Four Times (d) Remains same

**Kinetic Equation of gas**

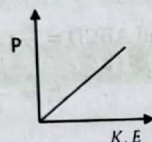
> Kinetic equation of gas is given as  $P = \frac{1}{3} \rho <v^2> = \frac{mN}{3V} <v^2>$

$$\Rightarrow PV = \frac{1}{3} mN <v^2>$$

**Relation between Pressure and <K.E>**

$$> P = \frac{mN}{3V} <v^2> = \frac{2N}{3V} <\frac{1}{2}mv^2>$$

$$\Rightarrow P = \frac{2N}{3V} <K.E>$$



> If  $\frac{N}{V} = N_0 = \text{constant}$  then  $P \propto <K.E>$

**General Gas Equation:**

> General gas equation for 'n' moles is given as  $PV = nRT$

Where R is general gas constant and in SI units  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

- > If n and T are constant then  $P \propto \frac{1}{V}$  (Boyle's law)
- > If n and T are constant then  $V \propto T$  (Charles's law)
- > If P and T are constant then  $V \propto n$  (Avogadro's law)
- > If n and V are constant then  $P \propto T$  (Lussac's law)

**Boltzman Constant: (k)**

The ratio of general gas constant to Avogadro's number is called Boltzmann constant.

$$> k = \frac{R}{N_A} \text{ and } k = \frac{8.314}{6.02 \times 10^{23}} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

**Example:** The product of Boltzmann and Avogadro's number (in SI units) is always equal to

- (a) 8.314 ✓ (b)  $6.02 \times 10^{23}$  (c)  $1.38 \times 10^{-23}$  (d) one

**Example:** The ratio of unit of Boltzmann to unit of General gas constant is equal to

- (a) mole (b)  $\text{mole}^{-1}$  ✓ (c)  $\text{J mole}^{-1}$  (d) one

**Solution:** As  $P \propto <v^2>$   
If  $<v^2>$  is doubled, P will become double.

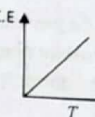
**Solution:**  
 $N_A \times k = R = 8.314$

**Solution:**  
 $\frac{\text{J mole}^{-1} \text{ K}^{-1}}{\text{J K}^{-1}} = \text{mole}^{-1}$

**Relation between Temperature and <K.E>**

> At any temperature T (Kelvin) <K.E> is given as  $K.E$

$$<K.E> = \frac{3}{2} kT$$



>  $<K.E> \propto T$

> Average K.E of molecules only depends upon temperature and independent of nature of gas.

**Example:** At room temperature which of the following gas molecules have greater average kinetic energy.

- (a)  $H_2$  (b)  $CO_2$  (c)  $N_2$  (d) All have same energy ✓

**Solution:**

Since temperature is same so <K.E> is also same.

**Example:**

At temperature  $27^\circ\text{C}$ , average K.E of gas molecules will be

- (a)  $6 \times 10^{-21} \text{ J}$  (b)  $60 \times 10^{-21} \text{ J}$   
(c)  $600 \times 10^{-21} \text{ J}$  (d)  $0.6 \times 10^{-21} \text{ J}$

**Solution:**  $<K.E> = \frac{3}{2} kT$   
(put  $T = 27 + 273 = 300 \text{ K}$ )  
 $= \frac{3}{2} (1.38 \times 10^{-23}) (300)$   
(put  $3 \times 1.38 \approx 4$ )  
 $= 600 \times 10^{-23} \text{ J} = 6 \times 10^{-21} \text{ J}$

**Boyle's Law:**

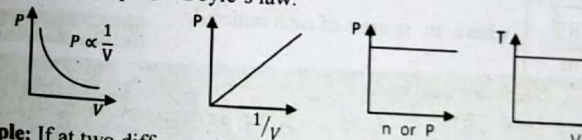
> If number of moles of gas and temperature are kept constant then volume of gas is inversely proportional to pressure.

>  $V \propto \frac{1}{P}$  (if n and T = constant)

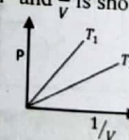
>  $PV = k$  (where k is constant and  $k = nRT$ )

>  $P_1 V_1 = P_2 V_2$

> Different graph for Boyle's law:



**Example:** If at two different constant temperatures  $T_1$  and  $T_2$  the graph between P and  $\frac{1}{V}$  is shown in the figure then.



- (a)  $T_1 > T_2$   
(c)  $T_1 = T_2$

- (b)  $T_1 < T_2$   
(d) None

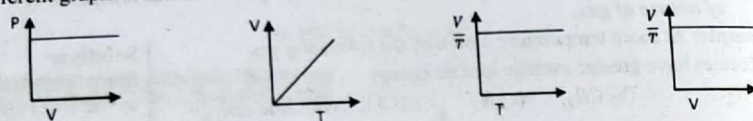
**Solution:**

$$\begin{aligned} \text{Slope of graph} &= \frac{P}{\left(\frac{1}{V}\right)} \\ &= PV = k = nRT \\ &\Rightarrow \text{Slope} \propto T \end{aligned}$$

Slope of  $T_2$  larger than  $T_1$   
so  $T_2 > T_1$

**Charles's Law**

- If number of moles of a gas and pressure are kept constant then volume of gas is directly proportional to its absolute temperature.
- $V \propto T$  (If  $n$  and  $P$  are constant)
- $\frac{V_1}{T_1} = \frac{V_2}{T_2}$  or  $V_1 T_2 = V_2 T_1$
- Different graph for Charles's law.

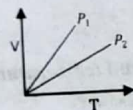


➤  $\frac{V}{T} = k$  (where  $k$  is constant and  $k = \frac{nR}{P}$ ) as  $PV = nRT \Rightarrow \frac{V}{T} = \frac{nR}{P}$

**Example:** If at two different constant pressures  $P_1$  and  $P_2$  the graph between volume and temperature of a gas is shown in the figure below then

- (a)  $P_1 > P_2$   
(c)  $P_1 = P_2$

- (b)  $P_1 < P_2$   
(d) None of these



**Solution:**

Slope of graph  $= \frac{V}{T} = \frac{nR}{P}$   
 $\Rightarrow \text{Slope} \propto \frac{1}{P}$   
 so  $P_2 > P_1$

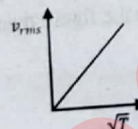
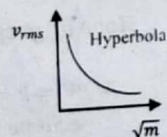
**Root mean square velocity:**

- Root mean square velocity is given as  $v_{rms} = \frac{\sqrt{v_1^2 + v_2^2 + \dots + v_N^2}}{N}$

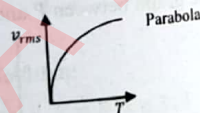
$$v_{rms} = \sqrt{\frac{3KT}{m}}$$

where 'm' is mass of each molecule.

- Root mean square velocity depends upon  
1. Temperature ( $v \propto \sqrt{T}$ )



2. Nature of the gas ( $v \propto \frac{1}{\sqrt{m}}$ ).



**Example:** At room temperature which of the following gas molecules will have greater root mean square velocity  
(a)  $H_2$  ✓ (b)  $CO_2$  (c)  $N_2$  (d) All have same energy

**Solution:**  
Since  $v_{rms} \propto \frac{1}{\sqrt{m}}$  Hence  $H_2$  has greater  $v_{rms}$ .

Other relations for root mean square velocity are

$$v_{rms} = \sqrt{\frac{3RT}{M}} \quad v_{rms} = \sqrt{\frac{3PV}{M}} \quad v_{rms} = \sqrt{\frac{3P}{\rho}}$$

**Internal Energy:**

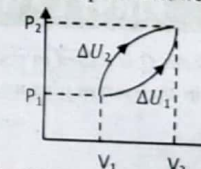
**Sum of all forms of molecule energies (P.E and K.E) is called internal energy.**

- For ideal gas molecule  $P.E = 0$ , because there is no force of attraction or repulsion between molecules.
- If gas is mono-atomic molecules possess only translational K.E.
- If gas is diatomic or polyatomic molecules possess translational, vibrational and rotational K.E.
- Since K.E only depends upon temperature and internal energy of an ideal gas only depends upon temperature.
- By **increases** temperature internal **energy increases** and vice versa.
- At constant temperature (isothermal process)  $U = \text{constant}$  and  $\Delta U = 0$ .
- **A function which only depends upon initial and final states and independent of path followed is called state function.**
- Change in internal energy is a state function (i.e independent of path followed)

یاد رکھیں  
 Ideal گیس کے لیے Internal Energy صرف گیس کے  
 Temperature پر depend کرتی ہے اور  
 Internal Energy  $\propto$  Temperature

- If a system changes state ( $P_1, V_1$ ) to ( $P_2, V_2$ ) along two different path as shown in figure then

$$\Delta U_1 = \Delta U_2$$

**Sign conventions:**

Heat added to system	Heat removed from system	Work done by the system	Work done on the system	If internal energy increases then $\Delta U$	If internal energy decreases then $\Delta U$
+ve	-ve	+ve	-ve	+ve	-ve

**Work done in thermodynamics:**

- Work done at constant pressure  $P$  is given as

$$W = P\Delta V \text{ or } W = P(V_f - V_i)$$

- Work done by the system is taken positive.
- Work done on the system is taken negative.
- **Area under  $P - V$  graph is equal to work done.**

**Example:** If volume  $V$  of gas increased by 200% at pressure  $P$  then the work done by the system is

- (a)  $PV$  (b)  $2PV$   
(c)  $3PV$  (d)  $4PV$

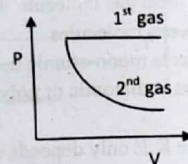
**Example:** P-V graph for two gases is shown in the figure below. For same change in volume which of following option is correct.

- (a)  $W_1 = W_2$  (b)  $W_1 < W_2$   
(c)  $W_1 > W_2$  (d)  $W_2 > W_1$  and  $W_1 = 0$

جس گراف کے area نیچے زیادہ ہو گا اس case میں work بھی زیادہ ہو گا۔

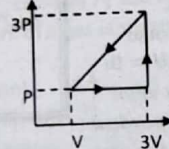
**Solution:**  $V_f = V + \frac{200V}{100} = 3V$   
 $W = P(V_f - V_i)$   
 $= P(3V - V) = 2PV$

**Solution:**  $W_1 > W_2$



**Example:** A system undergoes a cycle process as shown in the figure below then work done will be

- (a)  $PV$  (b)  $2PV$   
(c)  $3PV$  (d)  $4PV$



**Solution:**  
 $W_1 = \text{Area of triangle}$   
 $= \frac{1}{2}(3P - P)(3V - V)$   
 $= \frac{1}{2}(2P)(2V) = 2PV$

## FIRST LAW OF THERMODYNAMICS

When heat  $Q$  is added to system it appears as increases in internal energy which is stored in the system plus work done by the system.

$$Q = \Delta U + W$$

Where  $\Delta U$  is change in internal energy ( $\Delta U = U_f - U_i$ )

- First law of thermodynamics is actually law of conservation of energy in thermodynamics.

### Example 1: Bicycle Pump:

When we compress the air in a bicycle pump by closing its nozzle. Mechanical work is done on it. Since no heat flow occurs so this mechanical energy is converted into internal energy. Thus internal energy increases and its temperature increases.

### Example 2: Metabolism:

- Energy transforming process that occurs in an organism is called metabolism.  
 ➤ Energy from food we eat is stored in the body in form of internal energy.  
 ➤ By doing some mechanical work internal energy decreases.  $\Delta U = Q - W$

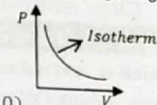
### Isothermal Process:

A process which is carried out at constant temperature is called isothermal process.

- Since  $T = \text{constant}$ , hence internal energy also remains constant and  $\Delta U = 0$ .  
 ➤ Boyle's law is valid

$$PV = \text{constant}$$

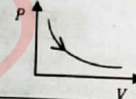
- Curve representing the isothermal process is called isotherm.  
 ➤ First law of thermodynamics takes the form  $Q = W$  ( $\because \Delta U = 0$ ).  
 ➤ Mostly process which are carried out slowly are isothermal.  
 ➤ For isothermal process modulus of elasticity of gas is equal to pressure of the gas ( $E = P$ ).



#### Isothermal Expansion

- $T = \text{Constant}$  and  $\Delta U = 0$   
 ➤ Work done is +ve.  
 ➤ Mechanical energy is converted into heat.  
 $Q = W$

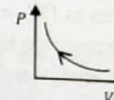
(مطلب ہو mechanical energy کہ دو heat کی شکل میں خارج ہوگی)



#### Isothermal Compression

- $\Delta U = 0$  and  $T = \text{Constant}$   
 ➤ Work done is -ve.  
 ➤ Heat is converted into mechanical energy.  $-Q = -W$

(مطلب ہو heat کہ دو work کرنے میں استعمال ہوگی)



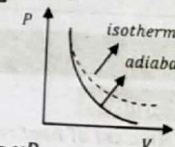
### Adiabatic Process

A process in which no heat enters or leaves from the system  $Q = 0$ .

- Temperature of the system may increase or decrease.  
 ➤ Relation between pressure and volume is

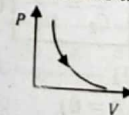
$$PV^\gamma = \text{constant}$$

- Curve representing the adiabatic process is called adiabat.  
 ➤ Adiabats are  $\gamma$  times steeper than isotherms.  
 ➤ First law of thermodynamics takes form  $W = -\Delta U$  ( $\because Q = 0$ )  
 ➤ Mostly process which are carried out rapidly are adiabatic.  
 ➤ For adiabatic process modulus of elasticity of gas is given as  $E = \gamma P$



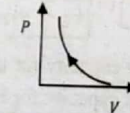
#### Adiabatic Expansion

- $Q = 0$   
 ➤ Work done is +ve.  
 ➤ Internal energy is converted into work.  
 $W = -\Delta U$   
 (مطلب ہو internal energy کہ دو work کرنے کی اتنی internal energy کم ہو جائے گی)  
 ➤ Internal energy decreases so temperature decreases.



#### Adiabatic Compression

- $Q = 0$   
 ➤ Work done is -ve.  
 ➤ Mechanical energy is converted into internal energy  $\Delta U = -W$   
 (مطلب ہو work کہ دو اتنی internal energy بڑھ جائے گی)  
 ➤ Internal energy increases so temperature increases.



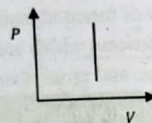
**Examples:**

- Compressions and rarefactions of air through which sound waves are passing.
- Rapid escape of air from burst tyre.
- Cloud formation.

**Isochoric process (Isometric process):**

A process which is carried out at constant volume is called isochoric process ( $\Delta V = 0$ ).

- No work is done ( $W = P\Delta V = 0$ ).
- First law takes the form.  $Q = \Delta U$
- If heat is added to system, internal energy increases thus temperature increases.
- If heat is removed from system, internal energy decreases.

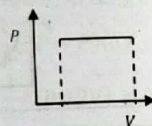


**Example:** Pressure cooker is an example of isochoric process in which volume is kept constant so  $W = 0$  and heat added is entirely converted into internal energy.

**Isobaric Process:**

A process carried out at constant pressure is called isobaric process.

- Work is given as ( $W = P\Delta V$ ).
- In isobaric expansion heat is partially converted into internal energy and partially into work.
- In isobaric compression work done on the system is partially converted into internal energy and partially into work.



Isothermal	Adiabatic	Isochoric
$\Delta U = 0$	$Q = 0$	$W = 0$
$Q = W$	$W = -\Delta U$	$Q = \Delta U$
$E = P$	$E = \gamma P$	$E = \infty$

**MOLAR SPECIFIC HEAT****Heat Capacity**

Amount of heat required to raise the temperature of a substance through one Kelvin is called heat capacity.

- It is denoted by  $C$  and

$$C = \frac{Q}{\Delta T}$$

- Its SI unit is  $JK^{-1}$  and in terms of base unit is  $Kgm^2s^{-2}K^{-1}$ .
- Boltzmann constant, entropy and heat capacity have same units.
- Heat capacity depends upon two factors

(i) Nature of substance

(ii) Amount of substance.

$$C \propto m \text{ or } \frac{C_1}{C_2} = \frac{m_1}{m_2} \text{ (m is mass) and } C \propto n \text{ or } \frac{C_1}{C_2} = \frac{n_1}{n_2} \text{ (n is number of moles)}$$

- Heat capacity for adiabatic process is zero. ( $\because Q = 0$ ).
- Heat capacity for isothermal process is infinite. ( $\because \Delta T = 0$ )

**Specific Heat:**

Amount of heat required to raise the temperature of 1 kg substance through one Kelvin is called specific heat.

- It is denoted by ' $c$ ' and

$$c = \frac{Q}{m\Delta T}$$

- Its SI unit is  $JKg^{-1}K^{-1}$  and in terms of base units is  $m^2s^{-2}K^{-1}$ .
- Specific heat only depends upon nature of substance and independent of amount of substance.
- For adiabatic process  $Q = 0 \Rightarrow c = \frac{Q}{m\Delta T} = 0$
- For isothermal process  $\Delta T = 0 \Rightarrow c = \frac{Q}{m\Delta T} = \infty$

**Example:** Ratio of specific heat of 2kg water to specific heat of 4kg is

- (a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 1 : 4

**Solution:** 1 : 1

(specific heat is independent of amount of substance)

**Molar Specific Heat:**

Amount of heat required to raise the temperature of one mole substance through one Kelvin is called molar specific heat.

- It is denoted by  $C$  and

$$C = \frac{Q}{n\Delta T}$$

- Its SI unit is  $Jmol^{-1}K^{-1}$
- General gas constant and molar specific heat have same units.
- Molar specific heat only depends upon nature of substance and independent of amount of substance.
- For adiabatic process  $Q = 0 \Rightarrow C = \frac{Q}{n\Delta T} = 0$
- For isothermal process  $\Delta T = 0 \Rightarrow C = \frac{Q}{n\Delta T} = \infty$

**In case of solids or liquids**

- When solids or liquids are heated their volume approximately remains constant.

$$V \approx \text{constant}$$

$$\Rightarrow \Delta V = 0 \text{ and } W = 0$$

$$\Rightarrow Q = \Delta U$$

- Heat is entirely converted into internal energy and no heat is used in doing work.

$$Q_v = nC_v\Delta T$$

And

$$\Delta U = nC_v\Delta T$$

**In case of gases**

- For gases, there are two types of molar specific heat
  1. Molar specific heat at constant volume
  2. Molar specific heat at constant pressure.

Molar specific heat at constant volume	Molar specific heat at constant Pressure
<ul style="list-style-type: none"> <li>➤ <math>V = \text{constant} \Rightarrow \Delta V = 0 \Rightarrow W = 0</math></li> <li>➤ First law takes the form, <math>Q = \Delta U</math></li> <li>➤ Heat is entirely converted into internal energy and no heat is used in doing work</li> </ul> $\Delta U = nC_v\Delta T$	<ul style="list-style-type: none"> <li>➤ <math>W = P\Delta V</math></li> <li>➤ First law take the form <math display="block">Q_P = \Delta U + P\Delta V</math></li> <li>➤ Heat is partially converted into internal energy and partially used in doing work.</li> </ul>

- Molar specific heat at constant pressure is always greater than molar specific heat at constant volume ( $C_P > C_V$ )

$$(C_P - C_V = R)$$

$$\gamma = \frac{\text{molar specific heat at constant pressure}}{\text{molar specific heat at constant volume}} \Rightarrow \gamma = \frac{C_P}{C_V}$$

- The value of  $\gamma$  is always greater than 1 and it has no dimension and no unit.

Gas	Mono Atomic	Diatomic	Polyatomic
$\gamma = \frac{C_P}{C_V}$	$\frac{5}{3} = 1.29$	$\frac{7}{5} = 1.4$	$\frac{9}{7} = 1.29$
$C_V = \frac{R}{\gamma - 1}$	$\frac{3R}{2}$	$\frac{5R}{2}$	$\frac{7R}{2}$
$C_P = \frac{\gamma R}{\gamma - 1}$	$\frac{5R}{2}$	$\frac{7R}{2}$	$\frac{9R}{2}$

$\gamma$  سے  $C_v$  معلوم کرنے کے لیے  $\gamma$  کی پہلے والی دہلی کو  $\frac{R}{2}$  سے multiply کریں۔

$C_P$  سے  $\gamma$  معلوم کرنے کے لیے  $\gamma$  کے اوپر والی دہلی کو  $\frac{R}{2}$  سے multiply کریں۔

**Example:**

In case of Helium Gas the value of molar specific heat at constant volume is

- (a)  $\frac{3R}{2}$  ✓ (b)  $\frac{5R}{2}$  (c)  $\frac{7R}{2}$  (d)  $\frac{9R}{2}$

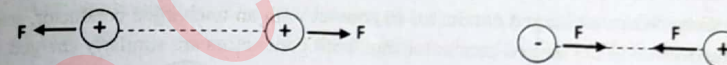
**Solution:**

Helium is a mono atomic gas

**UNIT 06 >>****ELECTROSTATICS****ELECTRIC CHARGE:**

Charge is property associated with matter due to which it produces and experiences electric and magnetic effects.

- There are two types of charge (i) Positive charge (ii) Negative charge
- Like charges repel each other and unlike charges attract each other.



**Example:** Which of the following is greatest value of charge?

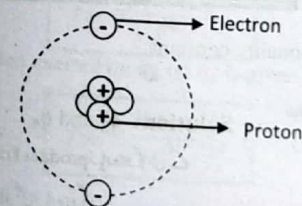
- (a) 10 C (b) 20 C (c) -5 C (d) -50 C ✓

- The smallest value of charge which can exist independently is  $e = 1.6 \times 10^{-19}C$

Particle	Electron or -ve $\beta$	Proton or +ve $\beta$	Neutron or $\gamma$ -rays	$\alpha$ -particle
Charge	$-e = -1.6 \times 10^{-19}C$	$+e = 1.6 \times 10^{-19}C$	Zero	$+2e = 3.2 \times 10^{-19}C$

- SI unit of charge is coulomb (in terms of base units A.s)
- Every atom is electrically neutral (No. of electrons = No. of Protons)

**Example:** He-Atom



$$\text{Net charge} = +2e - 2e = 0$$

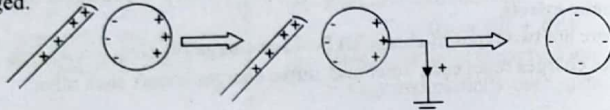
- Charge is quantized (charge is always an integral multiple of 'e')
- Law of conservation of charge

$$Q = ne$$

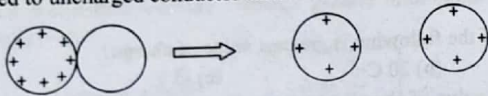
- Charge neither be created and nor be destroyed but can be transferred from one body to another and total charge always remains constant.
- Charge given to a conductor always resides on the outer surface.

**Methods of charging:**

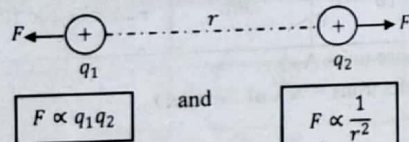
- By Friction:** By rubbing two bodies together both bodies are equally and oppositely charged due to transfer of electrons from one body to another.  
Examples: (i) When glass rod is rubbed with the silk, the glass rod becomes positively charged and silk is negatively charged. (ii) Clouds also get charged by friction.
- By Electrostatic Induction:** If a charged body is brought near a neutral body one side of neutral body (closer to charged body) is oppositely charged and while the other side is similarly charged.



- By Conduction:** When a charged conductor in contact with an uncharged conductor, some charge is transferred to uncharged conductor thus both conductors are similarly charged.

**COULOMB'S LAW**

Force between two point charges is directly proportional to product of magnitude of charges and inversely proportional to square of the distance between them

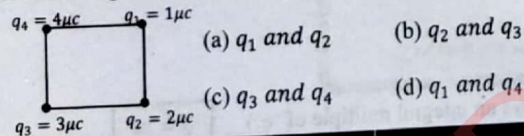


$$\Rightarrow F = \frac{Kq_1q_2}{r^2} \quad \text{Where } k \text{ is proportionality constant}$$

**Note**

Coulomb's Law is applicable only for point charge.

**Example:** If charges are placed at corners of a square as shown in figure below then force is maximum between



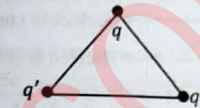
**Solution:**  $q_3$  and  $q_4$

جن charges کا product زیادہ ہو گا ان کے درمیان force بھی زیادہ ہو گی

Constant	Value in SI-units	SI unit	In terms of base units	Dimensions
<b>K</b> (in free space)	$9 \times 10^9$	$Nm^2C^{-2}$	$Kgm^3s^{-4}A^{-2}$	$ML^3T^{-4}A^{-2}$
$\epsilon_0$	$8.85 \times 10^{-12}$	$C^2N^{-1}m^{-2}$	$Kg^{-1}m^{-3}s^4A^2$	$M^{-1}L^{-3}S^4A^{-2}$

- $\epsilon_0$  is permittivity of free space and  $K = \frac{1}{4\pi\epsilon_0}$
- $F = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r^2}$

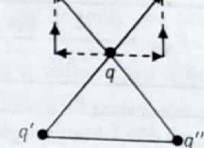
**Examples:** Three equal and similar charges are placed at the corners of an equilateral triangle as shown in the figure then resultant force on  $q$  is acting along



- (A) towards right (B) towards left  
(C) upward (D) downward

اس طرح کے questions کو solve کرنے کے لیے پہلے components میں resolve کریں اور پھر دیکھیں کہ کون سے components add ہو رہے ہیں اور کون سے cancel ہو رہے ہیں۔

**Solution** Horizontal component are cancelled and vertical component are added up



So the resultant force on  $q$  is in upward direction

1- Force ہمیشہ charges کو ملانے والی line کے along ہو گی۔

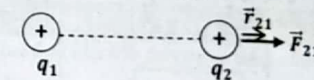
2- components بنانے کے لیے angle کے سامنے والے component کے ساتھ sine

دوسرے کے ساتھ Cos لگیں

**Vector Form of Coulomb's Law:**

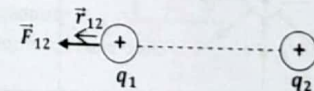
- Force exerted by  $q_1$  on  $q_2$  is given

$$\vec{F}_{21} = \frac{Kq_1q_2}{r^2} \hat{r}_{21}$$



- Force exerted by  $q_2$  on  $q_1$  is given as

$$\vec{F}_{12} = \frac{Kq_1q_2}{r^2} \hat{r}_{12}$$



- Both forces are always equal in magnitude but opposite in direction.
- Coulomb's law obey the Newton's 3<sup>rd</sup> law of motion.

$$\vec{F}_{12} = -\vec{F}_{21}$$

**Example:** If 4C and 6C charges are placed near each other the ratio of forces acting on the charges will be

- (a) 2 : 3 (b) 3 : 2 (c) 4 : 1 (d) 1 : 1 ✓

دو charges ہمیشہ ایک دوسرے پر برابر force لگاتے ہیں جب تک ایک charge کم اور

دوسرا زیادہ ہو

**Effect of medium:**

- Presence of dielectric medium (insulator) always reduces the electric force between the charges by a factor  $\epsilon_r$ .

$$F_{med} = \frac{F_{vac}}{\epsilon_r}$$

(اگر کوئی دو معلوم ہوں تو اس relation سے تیسری کو معلوم کریں)

$$F_{med} = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{q_1q_2}{r^2}$$

or

$\epsilon_r$  is known as

- Relative permittivity
- Dielectric constant
- Dielectric coefficient

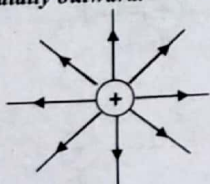
- $\epsilon_r$  is constant for given material and different for different materials.  
 ➤ Value of  $\epsilon_r$  is always greater than or equal to one for vacume:  $\epsilon_r = 1$ , for insulating materials  $\epsilon_r > 1$ , For metals:  $\epsilon_0 = \infty$   
 ➤  $\epsilon_r$  has no units, no dimensions.

Material	$\epsilon_r$	Material	$\epsilon_r$
Air	1.0006	Ammonia Liquid	22-25
Bakelite	5-18	Germanium	16
Glass	4.8-10	Paraffined paper	2
Rubber	2.94	Teflon	
Transformer oil	2.1	Water	78.5

**Electric Field Lines**

- Lines which provide information about strength and direction of electric field are called electric field lines.  
 ➤ The concept of field lines was introduced by Michael Faraday.

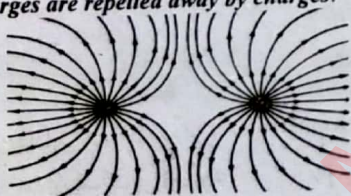
(i) Electric field lines due to positive point charge are radially outward.



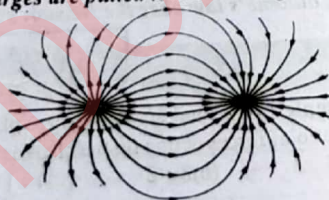
(ii) Electric field lines due to negative point charge are radially inward.



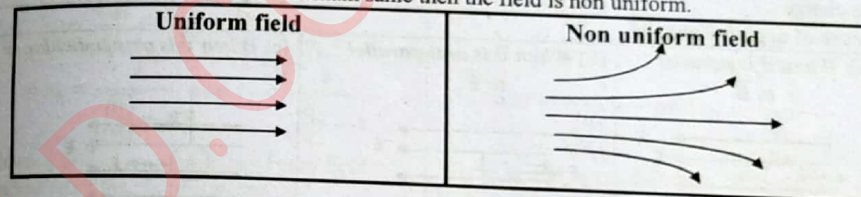
(iii) Electric field lines due to two similar charges are repelled away by charges.



(iv) Electric field lines due to two opposite charges are pulled towards charges.

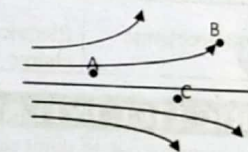
**Properties:**

- i. Electric field lines are imaginary lines to visualize the electric field.
- ii. No. of electric field lines  $\propto$  magnitude charge.
- iii. Electric field lines originate from positive charges and ends on negative charges.
- iv. Lines are closer where field is strong and lines are path farther apart where field is weak.
- v. Tangent to field lines at any point gives the direction of electric field at that point.
- vi. No two field lines can cross each other because electric field has only one direction at a given point.
- vii. If the distance between the lines remains same then field is uniform and if the distance between the line does not remain same then the field is non uniform.



**Example:** A non-uniform electric field is shown in the figure then at which of the following point electric field is maximum

- (a) A ✓ (b) B (c) C (d) same at all points

**Electric field:**

The space around the charge in which its electric force acts on other charge is called electric field

**ELECTRIC FIELD STRENGTH/INTENSITY**

Electric field intensity at any point is defined as electric force per unit charge placed at that point

$$\vec{E} = \frac{\vec{F}}{q}$$

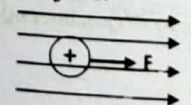
- Electric field intensity is a vector quantity.  
 ➤ SI unit =  $NC^{-1} = Vm^{-1}$ , unit in terms of base units =  $kgms^{-3}A^{-1}$ ,  
 ➤ Dimensions =  $[MLT^{-3}A^{-1}]$

**Electric force:** Force acting on a charge 'q' in an electric field  $\vec{E}$  is

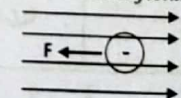
$$\vec{F}_e = q\vec{E}$$

- Electric force on a charge only depends upon magnitude of charge and electric field.  
 ➤ Electric force is independent of mass, velocity or direction of motion of charged particle.

Electric force on positive charge is always parallel to electric field.



Electric force on negative charge is always anti-parallel to electric field.



➤ Electric force can accelerate, decelerate and deflect the charge particle.

In case of positive charge

(a) When $\vec{v}$ is parallel to $\vec{E}$	(b) When $\vec{v}$ is anti-parallel to $\vec{E}$	(c) When $\vec{v}$ is perpendicular to $\vec{E}$
Electric field accelerate the charge	Electric field decelerate the charge	Electric field only deflect the charge

In case of negative charge.

(a) When $\vec{v}$ is parallel to $\vec{E}$	(b) When $\vec{v}$ is anti-parallel to $\vec{E}$	(c) When $\vec{v}$ is perpendicular to $\vec{E}$
Electric field decelerate the charge	Electric field accelerate the charge	Electric field only deflect the charge

## ELECTRIC FIELD INTENSITY DUE TO POINT CHARGE

Electric field intensity due to point charge at any distance  $r$  is given as

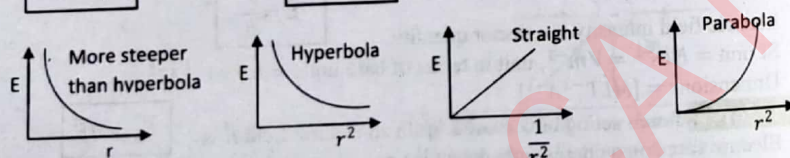
$$E = \frac{Kq}{r^2}$$

It only depends upon charge, distance from the charge  
And nature of the dielectric medium

$$E \propto q$$

OR

$$E \propto \frac{1}{r^2}$$



### Effect of Medium:

Presence of dielectric medium always reduces the electric field intensity by factor  $\epsilon_r$  times.

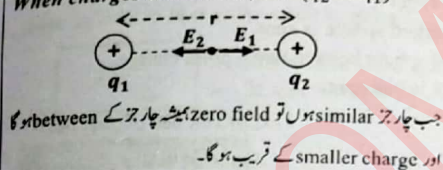
$$E_{med} = \frac{E_{vac}}{\epsilon_r}$$

$$E_{med} = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{q}{r^2}$$

(اگر کوئی دو quantities معلوم ہوں تو اس relation سے تیسری کو معلوم کریں)

## Zero Field Location:

When charges are similar, Let ( $q_2 < q_1$ )



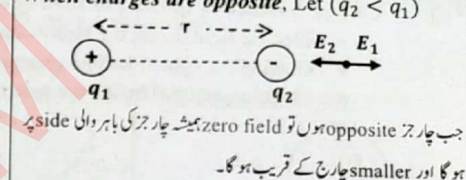
If  $\vec{E} = \vec{E}_1 - \vec{E}_2 = 0$  then  $E_1 = E_2$

$$\Rightarrow \frac{kq_1}{r_1^2} = \frac{kq_2}{r_2^2} \Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{q_1}{q_2}}$$

$$\Rightarrow r_1 = \frac{r}{\sqrt{\frac{q_2}{q_1} + 1}} \text{ and } r_2 = \frac{r}{\sqrt{\frac{q_1}{q_2} + 1}}$$

Where  $r_1$  and  $r_2$  are distances of zero field location from the charges  $q_1$  and  $q_2$  respectively

When charges are opposite, Let ( $q_2 < q_1$ )



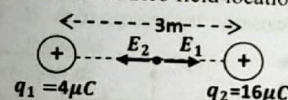
If  $\vec{E} = \vec{E}_1 - \vec{E}_2 = 0$  then  $E_1 = E_2$

$$\Rightarrow \frac{kq_1}{r_1^2} = \frac{kq_2}{r_2^2} \Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{q_1}{q_2}}$$

$$\Rightarrow r_1 = \frac{r}{\sqrt{\frac{q_2}{q_1} - 1}} \text{ and } r_2 = \frac{r}{\sqrt{\frac{q_1}{q_2} - 1}}$$

Where  $r_1$  and  $r_2$  are distances of zero field location from the charges  $q_1$  and  $q_2$  respectively

Examples: If  $4\mu\text{C}$  and  $16\mu\text{C}$  charges are separated by distance 3m. Then zero field location lies



- (a) 1m from  $16\mu\text{C}$   
(b) 2m from  $4\mu\text{C}$   
(c) 1m from  $4\mu\text{C}$  ✓  
(d) 4m from  $4\mu\text{C}$

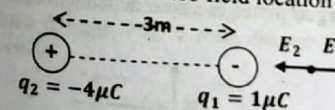
Solution:

As

$$r_1 = \frac{r}{\sqrt{\frac{q_2}{q_1} + 1}} = \frac{3}{\sqrt{\frac{16}{4} + 1}} = \frac{3}{2 + 1} = 1\text{m}$$

$$r_2 = 3 - 1 = 2\text{m}$$

Examples: If  $1\mu\text{C}$  and  $-4\mu\text{C}$  charges are separated by distance 3m. Then zero field location lies



- (a) 1m from  $-4\mu\text{C}$   
(b) 3m from  $-4\mu\text{C}$   
(c) 3m from  $1\mu\text{C}$  ✓  
(d) 6m from  $1\mu\text{C}$

Solution:

As

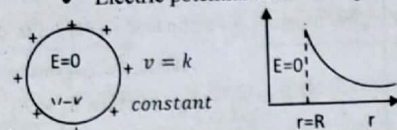
$$r_1 = \frac{r}{\sqrt{\frac{q_2}{q_1} - 1}} = \frac{3}{\sqrt{\frac{4}{1} - 1}} = \frac{3}{2 - 1} = 3\text{m}$$

$$r_2 = 3 + 3 = 6\text{m}$$

# ELECTRIC FIELD INTENSITY FOR DIFFERENT CHARGE DISTRIBUTION

## (i) Charge conducting sphere (or shell of charge)

- Electric field inside the hollow charged sphere is zero.
- Outside the sphere hollow charged sphere behave like a point charge.
- Electric potential inside the sphere is constant.



اس region میں electric field بھی zero ہے  
اس region میں potential کا مشتق ہو گا۔

Inside the sphere or shell ( $r < R$ )	On surface of sphere or shell ( $r = R$ )	On surface of sphere or shell ( $r > R$ )
$E = 0$	$E = \frac{kq}{R^2}$	$E = \frac{kq}{r^2}$

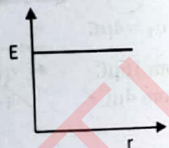
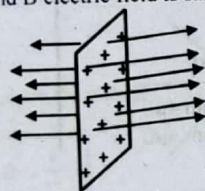
To eliminate the stray of Electric field interference sensitive electronic devices such as T.V or computer are often enclosed in metal boxes

## (ii) Infinite sheet of charge:

- Electric field intensity due to infinite sheet of charge is independent of distance from the sheet. For example at point A and B electric field is same.

$$E = \frac{\sigma}{2\epsilon_0}$$

$$E = \frac{Q}{2A\epsilon_0}$$

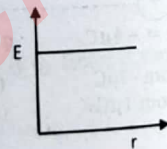


## (ii) Between two closely spaced and oppositely charged plates (capacitor):

- Electric field intensity between two oppositely charged plates is also independent of distance.

$$E = \frac{\sigma}{\epsilon_0}$$

$$E = \frac{Q}{A\epsilon_0}$$



## Electric Potential: (Absolute Potential)

Electric potential at any point is defined as work done in bringing a unit positive charge from infinity to that point while keeping the charge in equilibrium.

$$V = \frac{W}{q_0}$$

➤ Potential is scalar quantity.

➤ SI unit = volt =  $JC^{-1} = kgm^2s^{-3}A^{-1}$ , Dimensions =  $[ML^2T^{-3}A^{-1}]$

## Potential difference:

Potential difference between two points is defined as work done in bringing a unit positive charge from one point to another while keeping the charge in equilibrium.

$$V_A - V_B = \frac{W}{q_0}$$

$$\Delta V = \frac{W}{q_0}$$

## Work done on the charge:

When a particle of charge  $q$  and mass  $m$  passes through P.d  $V$  then work done on it is given as

$$W = qV$$

➤  $W \propto q$  and  $W \propto V$

➤  $W$  is independent of mass of particle

## Gain in speed:

The gain in speed of particle when it is accelerated by P.d  $V$  is given as

$$v = \sqrt{\frac{2qV}{m}}$$

➤  $v \propto \sqrt{q}$

➤  $v \propto \sqrt{V}$

➤  $v \propto \frac{1}{\sqrt{m}}$

## Change in potential energy:

When a particle of charge  $q$  and mass  $m$  passes through P.d,  $V$  then change in P.E is given as

$$\Delta P.E = qV$$

➤  $\Delta P.E \propto q$  and  $\Delta P.E \propto V$

➤  $\Delta P.E$  is independent of mass of particle

## Gain in momentum

The gain in momentum of a particle when it is accelerated through P.d  $V$  is given as

$$p = \sqrt{2mqV}$$

➤  $p \propto \sqrt{m}$

➤  $p \propto \sqrt{q}$

➤  $p \propto \sqrt{V}$

## Change in kinetic energy:

When a particle of charge  $q$  and mass  $m$  passes through P.d,  $V$  then change in K.E is given as

$$\Delta K.E$$

➤  $\Delta K.E \propto q$  and  $\Delta K.E \propto V$

➤  $\Delta K.E$  is independent of mass of particle

## Example:

If an electron and a proton are accelerated through same P.d then which of the following statement is true

(a) both will gain equal K.E

(b) electron will gain greater speed

(c) proton will gain greater momentum

(d) all of these ✓

**Example:**

If an electron and a proton are accelerated through same P.d then which one will gain greater momentum

- (a) Electron (b) Proton (c) Both gain same (d) None

**Solution:** As  $m_p > m_e$   
and  $P \propto \sqrt{m}$   
So proton will gain greater momentum.

**Potential Gradient**

- > The quantity  $\left(\frac{\Delta V}{\Delta r}\right)$  which gives the maximum rate of change of potential  $\Delta r$  with distance is called potential gradient.
- > Its SI unit is  $Vm^{-1} = NC^{-1} = kgms^{-3}A^{-1}$
- > Electric field intensity and potential gradient have same units.
- > Potential gradient is a vector quantity.

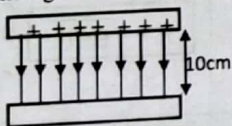
**Relation with electric field**

- > Electric field is equal to -ve potential gradient.

$$\vec{E} = -\frac{\Delta V}{\Delta r}$$

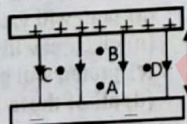
- > If  $E = 0 \Rightarrow \Delta V = 0$  and  $V = \text{constant}$
- > If  $V = \text{constant}$  then  $\Delta V = 0 \Rightarrow E = 0$
- > In direction of electric field potential decreases.
- > In opposite direction of electric field potential increases.
- > In perpendicular direction of electric field potential remains same.

**Example:** P.d. between two oppositely charged parallel plates is 12V as shown in the figure then electric field between the plates will be



- (a)  $1.2NC^{-1}$  (b)  $12NC^{-1}$  (c)  $120NC^{-1}$  (d) Zero

**Example:** P.d. between two oppositely charged parallel plates is 12V as shown in the figure then electric field between the plates will be



- (a) Potential is maximum at B (b) Potential is minimum at A  
(c) Potential is same at C & D (d) All of these ✓

**Solution:**

$$E = \frac{V}{d} = \frac{12}{10 \times 10^{-2}} = 120NC^{-1}$$

**Solution:**

Correct option is d  
In direction of electric field potential decreases but in perpendicular direction potential remains constant.

**ELECTRIC POTENTIAL DUE TO POINT CHARGE**

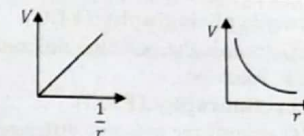
Electric potential at any distance  $r$  due to a point charge  $q$  is given as

$$V = \frac{kq}{r}$$

$$V \propto q$$

and

$$V \propto \frac{1}{r}$$

**Note**

- Potential due to +ve charge is +ve
- Potential due to -ve charge is -ve

- > In presence of dielectric medium potential decreases by  $\epsilon_r$  times

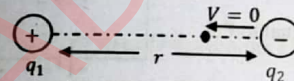
$$V_{med} = \frac{V_{vac}}{\epsilon_r}$$

OR

$$V_{med} = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{q}{r}$$

**Zero Potential Location**

- a) When charges are opposite (let  $q_2 < q_1$ )



$$\frac{r_1}{r_2} = \frac{q_1}{q_2}$$

یاد رکھیں

اگر چارج opposite ہوں تو Zero Potential ہمیشہ چارج کے درمیان ہو گا اور smaller چارج کے قریب ہو گا۔

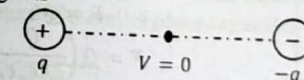
Distance of zero potential point from first charge

$$r_1 = \frac{q_1 r}{q_1 + q_2}$$

Distance of zero potential point from second charge

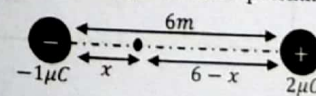
$$r_2 = \frac{q_2 r}{q_1 + q_2}$$

**Example:** Potential at a point midway between two equal and opposite charges is



- (a)  $\frac{kq}{r}$  (b)  $\frac{2kq}{r}$  (c)  $\frac{kq}{2r}$  (d) zero

**Example:** If  $-1\mu C$  and  $2\mu C$  charges are separated by distance 6m then find the position of point where potential is zero



- (a) 2m from  $-1\mu C$  (b) 2m from  $2\mu C$   
(c) 1m from  $-1\mu C$  (d) 1m from  $2\mu C$

**Solution:**

$$V = V_+ + V_- = \frac{kq}{r} - \frac{kq}{r} = 0$$

**Solution:**

$$x = \frac{q_1 r}{q_1 + q_2} = \frac{1 \times 6}{1 + 2} = 2m$$

zero potential point lies 2m from  $-1\mu C$  charge and 4m from  $2\mu C$  charge

- b) When charges are similar (both are +ve or both are -ve) then zero potential point lies at infinity.

### Electro Cardio Graphy:(ECG)

An ECG records the voltages between points on human skin generated by heart and it provide information about the performance of heart.

### Electroencephalography:(EEG)

An EEG records the potential difference created by brain and provide information about for abnormal behavior.

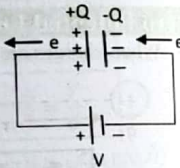
### Electroretinography:(ERG)

An ERG records the potential difference generated by retina

## CAPACITOR

Capacitor is a device which can store electric charge.

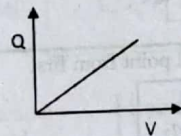
- When battery is connected across the plates of parallel plate capacitor, battery removes electrons from one plate and transfers electrons to other plate.
- Capacitor continue charging until its P.d becomes equal to P.d of the battery.
- Net charge on a capacitor is always zero.



Charge on the capacitor is directly proportional to P.d across the plates of capacitor.

$$Q \propto V \quad \text{OR} \quad Q = CV$$

Where C is proportionality constant known as capacitance.



- Slope  $\frac{Q}{V} = C$
- Area under the graph = P.E  $\frac{1}{2} QV$

Electric field intensity between plates of capacitor is

$$E = \frac{\sigma}{\epsilon_0 \epsilon_r} = \frac{Q}{A \epsilon_0 \epsilon_r}$$

Relation between electric field and P.d across the capacitor is

$$E = \frac{V}{d}$$

Electric force between the plates of capacitor is given as

$$F = QE$$

$$F = Q \left( \frac{Q}{2A \epsilon_0 \epsilon_r} \right)$$

$$F = \frac{Q^2}{2A \epsilon_0 \epsilon_r}$$

## CAPACITANCE

Capacitance of parallel plate capacitor is defined as amount of charge on one plate necessary to raise its potential by one volt w.r.t. other plate.

$$C = \frac{Q}{V}$$

### Note

C is proportionality constant and it is independent of Q and V

- SI unit of capacitance is farad.
- $F = CV^{-1} = kg^{-1} m^{-2} s^4 A^{-2}$   
(Dimensions =  $[M^{-1} L^{-2} T^4 A^{-2}]$ )
- Capacitance of parallel plate capacitor is given as

$$C_{med} = \frac{A \epsilon_0 \epsilon_r}{d}$$

OR

$$C_{vac} = \frac{A \epsilon_0}{d}$$

It only depends upon three factors.

- Area of the plates  $C \propto A$ .
- Distance between the plates  $C \propto \frac{1}{d}$
- Medium between the plates  $C \propto \epsilon_r$

### Examples:

If length, width and thickness of plates of a capacitor are doubled then its capacitance will become

- Double
- Four Times
- Eight Times
- Remains same

### Dielectric Constance:

The ratio of capacitance of parallel plate capacitor when dielectric is as medium between the plates to capacitance of parallel plate capacitor when vacuum is medium between the plates.

$$\epsilon_r = \frac{C_{med}}{C_{vac}}$$

$$\text{Since } C_{med} > C_{vac} \Rightarrow \epsilon_r > 1$$

- It only depends on nature of the medium
- Its value is always greater or equal to one
- It has no unit no dimensions

### یاد رکھیں

Capacitor کی plates کے درمیان dielectric رکھنے سے capacitance ہمیشہ  $\epsilon_r$  گنا زیادہ ہو جائے گی

**Solution** Since C is independent of thickness and  $C \propto A \Rightarrow C \propto \text{length} \times \text{width}$  Hence capacitance becomes four times.

**Energy Stored in Capacitor:**

- Capacitor is a device which can store the charge, alternatively capacitor is a device which can store electrical energy.
- Charge stored on plates of capacitor posses electrical P.E arises due to work done by battery to deposite charge on the plates.
- P.E stored on the plates of capacitor is given as

i.  $P.E = \frac{1}{2} QV$

ii.  $P.E = \frac{1}{2} CV^2$

iii.  $P.E = \frac{Q^2}{2C}$

کونسا relation کب use کرتا ہے یہ question میں  
ہی information نہ depend کرتا ہے

- Energy stored in the capacitor can be regarded that energy is stored in form of electric field between the plates instead of P.E of the charges on the plates.

$$P.E = \frac{1}{2} \epsilon_0 \epsilon_r E^2 (Ad)$$

And

$$\text{Energy density} = \frac{1}{2} \epsilon_0 \epsilon_r E^2$$

**Three Important cases for capacitor**

- I. If battery remains connected across capacitor or capacitors are connected in parallel then  $V = \text{constant}$

As  $Q = CV \Rightarrow Q \propto C$  or  $\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$

and  $P.E = \frac{1}{2} CV^2 \Rightarrow P.E \propto C$  or  $\frac{P.E_1}{P.E_2} = \frac{C_1}{C_2}$

**Example:**

A capacitor is connected across a 12V battery. If a dielectric medium is introduced between the plates then which of the following statement is true.

- (a) Capacitance increases (b) Charge increases  
(c) Energy increases (d) All of these ✓

**Solution:**

As  $V = \text{constant}$  so  
 $Q \propto C$  and  $P.E \propto C$   
By introducing dielectric  $C$  increases so  $Q$  and  $P.E$  also increases.

**Example:**

If  $4\mu F$  and  $6\mu F$  capacitor are connected in parallel that the ratio between charge stored in capacitor and energy stored in capacitor will be

- (a) 2 : 3 and 2 : 3 ✓ (b) 2 : 3 and 3 : 2  
(c) 3 : 2 and 3 : 2 (d) 3 : 2 and 2 : 3

**Solution:**

Since  $V = \text{constant}$ .  
Hence  $\frac{Q_1}{Q_2} = \frac{C_1}{C_2} = \frac{4}{6} = 2 : 3$   
and  $\frac{P.E_1}{P.E_2} = \frac{C_1}{C_2} = \frac{4}{6} = 2 : 3$

2. If battery is not connected to capacitor (isolated capacitor) or capacitor are connected in series then  $Q = \text{constant}$

$$Q = CV \Rightarrow V \propto \frac{1}{C} \text{ and } \frac{V_1}{V_2} = \frac{C_2}{C_1}$$

and  $P.E = \frac{Q^2}{2C} \Rightarrow P.E \propto \frac{1}{C} \text{ and } \frac{P.E_1}{P.E_2} = \frac{C_2}{C_1}$

**Example:** If distance between the plates of a charged capacitor is doubled then energy stored in capacitor will become

- (a) Double ✓ (b) Half  
(c) Four Times (d) Remains same

**Solution**

As  $Q = \text{constant}$   
so  $P.E \propto \frac{1}{C}$  and  $C \propto \frac{1}{d}$   
by doubling distance  $C$  becomes half thus energy becomes double

**Example:** If  $C_1 = 2\mu F$  and  $C_2 = 4\mu F$  are connected in series then ratio between their voltages will be

- (a) 1 : 1 (b) 1 : 2  
(c) 2 : 1 (d) 1 : 4

**Solution:** As  $Q = \text{constant}$

so  $V \propto \frac{1}{C}$   
As  $\frac{C_1}{C_2} = \frac{1}{2} \Rightarrow \frac{V_1}{V_2} = \frac{2}{1}$

3. If area of plates distance between the plates and medium between the plates are not changed then  $C = \text{constant}$

As  $Q = CV \Rightarrow Q \propto V$  or  $\frac{Q_1}{Q_2} = \frac{V_1}{V_2}$

and  $P.E = \frac{1}{2} CV^2 \Rightarrow P.E \propto V^2$

**Example:** If voltage across capacitor is doubled then energy stored in capacitor will becomes

- (a) Double (b) Half  
(c) Four Times ✓ (d) Remains same

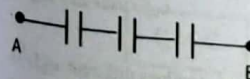
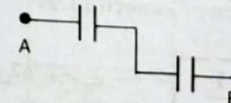
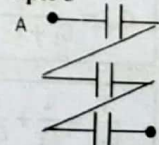
**Solution:** As  $C = \text{constant}$

$P.E = \frac{1}{2} CV^2 \Rightarrow P.E \propto V^2$   
If  $V$  is doubled then energy will become four times

**SERIES COMBINATION OF CAPACITORS**

If capacitors end to end such that same charge is stored across all of them then this combination is known as series combination.

(اگر capacitors ایک ہی path میں connected ہوں تو capacitors سیریز میں ہوں گے)

**Example 1****Example 2****Example 3**

- When capacitors are connected in series charge on each capacitor is same

$$Q_1 = Q_2 = Q \text{ (Total charge)}$$

$$\Rightarrow \frac{Q_1}{Q_2} = 1$$

When capacitors are connected in series, total voltage is divided among the capacitors.

$$V = V_1 + V_2$$

As Q is same so

$$V \propto \frac{1}{C}$$

and

$$\frac{V_1}{V_2} = \frac{C_2}{C_1}$$

(جس کی capacitance زیادہ ہوگی اس کے

voltage drop زیادہ ہوگا)

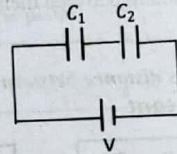
### Voltage Divider Rule:

If two capacitors are connected in series with voltage V as shown in figure

$$\frac{V_1}{V_2} = \frac{C_2}{C_1}$$

and

$$\frac{V_1}{V_2} = \frac{C_2}{C_1}$$



Voltage drop across the capacitor  $C_1$  and  $C_2$  is given as

$$V_1 = \frac{C_2}{C_1 + C_2} V$$

$$V_2 = \frac{C_1}{C_1 + C_2} V$$

یاد رکھیں  
(اگر capacitors کی capacitances برابر ہوں تو ان میں voltage بھی برابر drop ہوگا)

- As Q is same so  $P.E = \frac{Q^2}{2C} \Rightarrow P.E \propto \frac{1}{C}$  (جس کی capacitance زیادہ ہوگی اس میں کم انرجی store ہوگی)

### Equivalent Capacitance:

If 'n' number of capacitors are connected in series

1. (سب سے پہلے دیکھیں اگر capacitors کی values different ہوں تو capacitance کو divide کر دیں)
- $$C_{eq} = \frac{C}{n}$$

2. (اگر دو different values والے capacitor ہوں تو ان فارمولے کو use کریں)
- $$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{\text{Product of capacitances}}{\text{Sum of capacitances}}$$

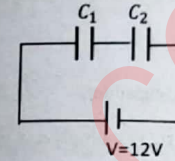
3. (اگر زیادہ values different والے capacitor ہوں تو ان فارمولے کو use کریں)
- $$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}$$

4.  $C_{eq} < C_{min}$

5. To decrease the capacitance capacitors are connected in series.

### Example:

If two capacitors  $C_1 = 4\mu F$  and  $C_2 = 6\mu F$  are connected in series with a 12V battery as shown



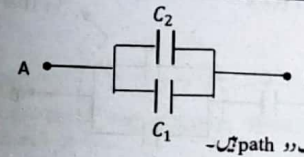
Then

- i.  $C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{4 \times 6}{4 + 6} = \frac{24}{10} = 2.4\mu F$   
 ii.  $Q_1 = Q_2 = Q = C_{eq} V = 2.4 \times 12\mu C = 28.8\mu C$  and  $\frac{Q_1}{Q_2} = 1$   
 iii.  $V_1 = \frac{C_2}{C_1 + C_2} V = \frac{6}{4 + 6} \times 12 = 7.2V$   
 iv.  $V_2 = \frac{C_1}{C_1 + C_2} V = \frac{4}{4 + 6} \times 12 = 4.8V$  and  $\frac{V_1}{V_2} = \frac{C_2}{C_1} = \frac{3}{2}$   
 v.  $V_1 + V_2 = 7.2 + 4.8 = 12V = V$

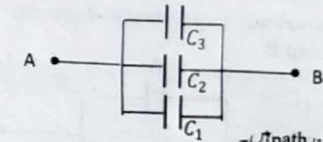
### PARALLEL COMBINATION OF CAPACITORS

If capacitors are connected side by side such that same potential difference is applied across all of them then this combination is known as parallel combination.

اگر ایک پوائنٹ سے دوسرے پوائنٹ charges گزرنے کے لیے ایک سے زیادہ path ہوں تو capacitors آپس میں parallel ہوں گے



path دو تک B سے A



path تین تک B سے A

- When capacitors are connected in parallel then voltage across each capacitor is same

$$V_1 = V_2 = V$$

And

$$\frac{V_1}{V_2} = 1$$

When capacitors are connected in parallel total charge is divided among the capacitors

$$Q = Q_1 + Q_2$$

As V is same so

$$Q \propto C$$

and

$$\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$$

(جس کی capacitance زیادہ ہوگی اس پر زیادہ چارج store ہوگا)

$$P.E \propto C$$

and

$$\frac{P.E_1}{P.E_2} = \frac{C_1}{C_2}$$

(جس کی capacitance زیادہ ہوگی اس پر زیادہ انرجی store ہوگی)

**Charge divider Rule**

If two capacitors are connected in parallel then total charge  $Q$  is divided among them as

$$Q_1 = \frac{C_1}{C_1 + C_2} Q \quad \text{and} \quad Q_2 = \frac{C_2}{C_1 + C_2} Q$$

As  $V$  is same and  $P.E = \frac{1}{2} CV^2$  so

(جس کی capacitance زیادہ ہوگی اس میں زیادہ انرجی store ہوگی)

**Equivalent Capacitance:**

If 'n' no. of capacitors are connected in parallel then

$$C_{eq} = nC$$

(سب سے پہلے دیکھیں اگر capacitors کی ویلیوز same ہیں تو

capacitance کو تعداد سے multiply کریں)

$$C_{eq} = C_1 + C_2 + C_3 + \dots + C_n$$

(اگر different values والے capacitors ہوں تو سب

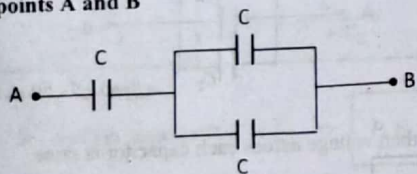
sum capacitances کریں)

➤  $C_{eq} > C_{max}$

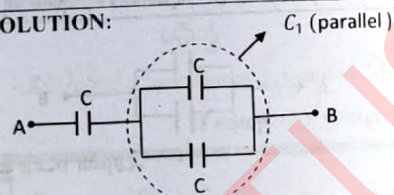
➤ To increase the capacitance capacitors are connected in parallel.

**PRACTICE EXAPLES****EXAMPLE1:**

Find equivalent capacitance between the points A and B



**SOLUTION:**

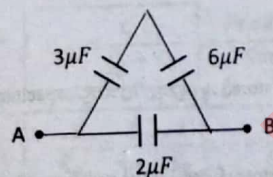


$$C_1 = C + C = 2C$$

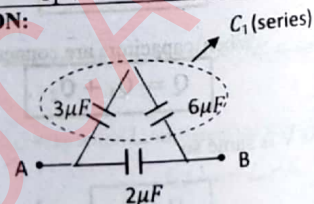
$$C_{eq} = \frac{C_1 \times C}{C_1 + C} = \frac{2C \times C}{2C + C} = \frac{2C}{3}$$

**EXAMPLE2:**

Find equivalent capacitance between the points A and B



**SOLUTION:**

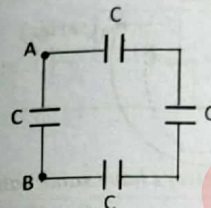


$$C_1 = \frac{3 \times 6}{3 + 6} = 2$$

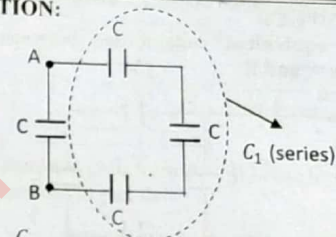
$$C_{eq} = C + C_1 (\text{parallel}) = 2 + 2 = 4\mu F$$

**EXAMPLE3:**

Find equivalent capacitance between the points A and B



**SOLUTION:**

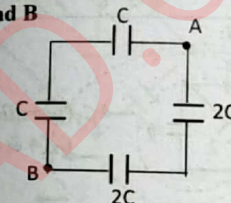


$$C_1 = \frac{C}{3} \quad (\text{capacitors have same value})$$

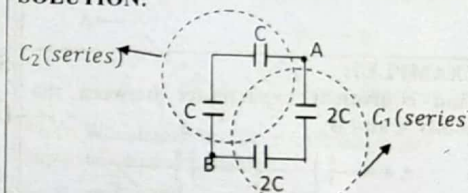
$$C_{eq} = C + C_1 (\text{parallel}) = C + \frac{C}{3} = \frac{4C}{3}$$

**EXAMPLE4:**

Find equivalent capacitance between the points A and B



**SOLUTION:**



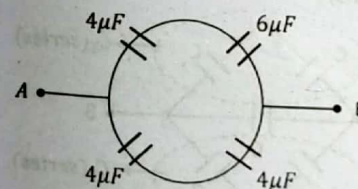
$$C_1 = \frac{2C}{2} = C \quad (\text{capacitors have same value})$$

$$C_1 = \frac{C}{2} \quad (\text{capacitors have same value})$$

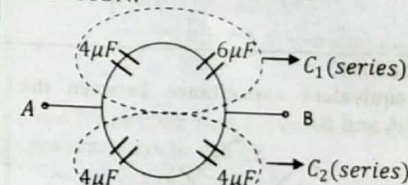
$$C_{eq} = C + \frac{C}{2} (\text{parallel}) = \frac{3C}{2}$$

**EXAMPLE5:**

Find equivalent capacitance between the points A and B



**SOLUTION:**



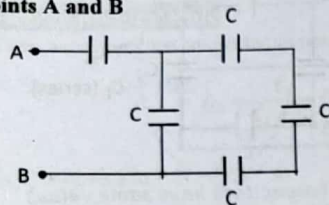
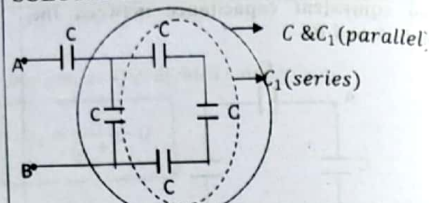
$$C_1 = \frac{4 \times 6}{4 + 6} = 2.4$$

$$C_2 = \frac{4\mu F}{2} \quad (\text{capacitors have same value})$$

$$C_{eq} = C_1 + C_2 = 2 + 2.4 = 4.4\mu F$$

**EXAMPLE6:**

Find equivalent capacitance between the points A and B

**SOLUTION:**

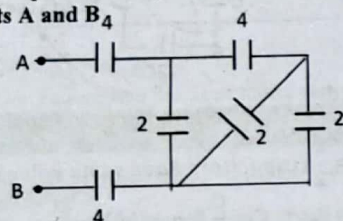
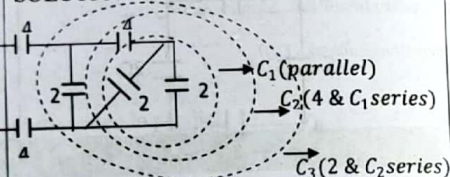
$$C_1 = \frac{C}{3} \text{ (capacitors have same value)}$$

$$C_2 = C + C_1 = C + \frac{C}{3} = \frac{4C}{3}$$

$$C_{eq} = \frac{C \times \frac{4C}{3}}{C + \frac{4C}{3}} = \frac{4C}{7}$$

**EXAMPLE7:**

Find equivalent capacitance between the points A and B

**SOLUTION:**

$$C_1 = 2 + 2 = 4$$

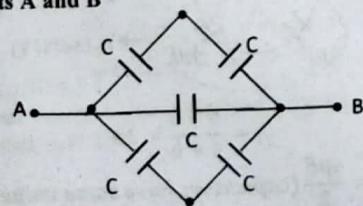
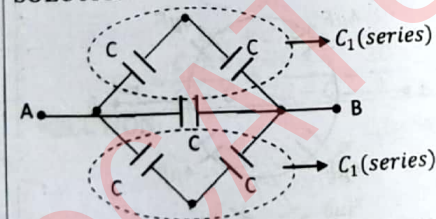
$$C_2 = \frac{4}{2} = 2 \text{ (same values)}$$

$$C_3 = 2 + 2 = 4$$

$$C_{eq} = \frac{4}{3}$$

**EXAMPLE6:**

Find equivalent capacitance between the points A and B

**SOLUTION**

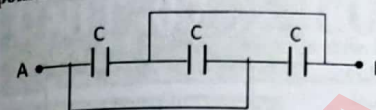
$$C_1 = \frac{C}{2} \text{ (capacitors have same value)}$$

$$C_2 = \frac{C}{2} \text{ (capacitors have same value)}$$

$$C_{eq} = C + \frac{C}{2} + \frac{C}{2} = 2C$$

**EXAMPLE6:**

Find equivalent capacitance between the points A and B

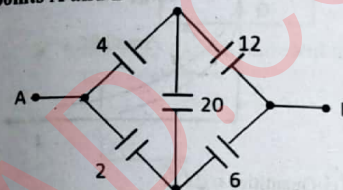
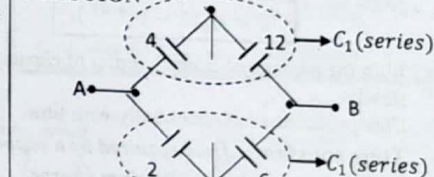
**SOLUTION**

There are three path from A to B hence three capacitors are in parallel

$$C_{eq} = \frac{C}{3} \text{ (capacitors have same value)}$$

**EXAMPLE6:**

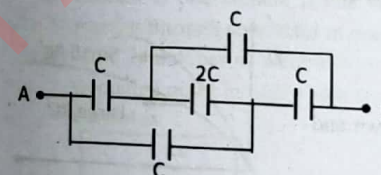
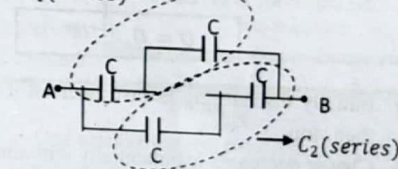
Find equivalent capacitance between the points A and B

**SOLUTION**

Since Wheatstone bridge is satisfied so 20F capacitance can be deleted

$$C_1 = \frac{4 \times 12}{4 + 12} = 3 \text{ and } C_2 = \frac{2 \times 6}{2 + 6} = 1.5$$

$$C_{eq} = 3 + 1.5 = 4.5$$

**SOLUTION**

Since Wheatstone bridge is satisfied so 2C capacitance can be deleted

$$C_1 = \frac{C}{2} \text{ (capacitors have same value)}$$

$$C_2 = \frac{C}{2} \text{ (capacitors have same value)}$$

$$C_{eq} = \frac{C}{2} + \frac{C}{2} = C$$

## CHARGING AND DISCHARGING OF CAPACITORS

## Charging of capacitor :

- To charge the capacitor, capacitor is connected with a voltage source (battery) as shown in the figure below
- Charging of a capacitor continues until the potential difference of capacitor becomes equal to the potential difference of source.
- At any instant the charge on the plates of capacitor is given as

$$Q = Q_0(1 - e^{-t/RC})$$

- With the passage of time charging of capacitor slowly.
- Charge increases exponentially with time
- **Time constant:** Time required by a capacitor to deposit 0.63 or 63% equilibrium charge.

$$t = RC$$

اگر کوئی دو Quantities دی گئی ہوں تو اس relation سے تیری معلوم کریں

Unit: It's unit is second.

## Discharging of Capacitor:

- To discharge the capacitor at any instant 't' charge on the capacitor is given as

$$Q = Q_0 e^{-t/RC}$$

- Initially discharging is fast, later on it slow down and then stop
- Charge decreases exponentially with time.
- **Time constant:**

Time required to discharge 0.63 or 0.63% of equilibrium charge is called time constant.

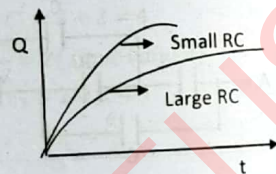
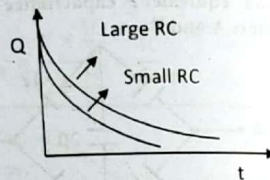
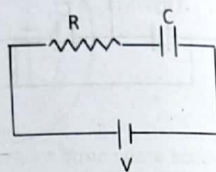
$$t = RC$$

اگر کوئی دو Quantities دی گئی ہوں تو اس relation سے تیری معلوم کریں

- Unit of RC is second  $ohm \times forced = sec$
- After time equal to time constant ( $t = RC$ ), 63% capacitor is discharged and remaining charge on the capacitor is 37%.

## Interesting Application

The charging and discharging of a capacitor enables some windshield wipers of cars to be used intermittently during a light drizzle in this mode of operation the wipers remain off for a while and turn on briefly. The timing of on-off cycle is determined by time constant of visitor-capacitor combination.



## UNIT 07 &gt;&gt; CURRENT ELECTRICITY

## ELECTRIC CURRENT:

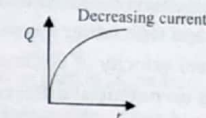
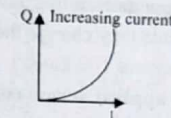
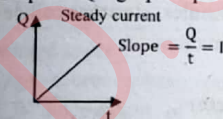
- Rate of flow of charge is called electric current or charge passing through cross section area of the conductor per unit time is called current.
- Average current is given as

$$I_{av} = \frac{\Delta Q}{\Delta t}$$

Voltage بر Coulomb چارن کی اثری کو ظاہر کرتا ہے۔

Current بر سینکڑوں گزرنے والے چار جزی تعداد کو ظاہر کرتا ہے۔

- Slope of Q-t graph represent the current



- Current is a scalar quantity.
- Current is a base quantity and its SI unit is ampere ( $A = Cs^{-1}$ )
- Current is one ampere if one coulomb charge is passing through conductor in one second.
- If 'n' is number of electrons (or protons) passing through a point in time t then  $Q = ne$  and average current is

$$I = \frac{ne}{t}$$

یاد رکھیں

Current کی direction ہونے کے باوجود یہ ایک

scalar quantity ہے۔

## Note

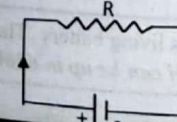
One ampere current means  $6.25 \times 10^{18}$  electrons are passing through a conductor in one second

## Charge Carriers:

Substance	Metals	Electrolytes	Gases	Semi-conductors
Charge carriers	Free electron	Positive and negative electron	Ions and free $e^-$	Free electrons and holes

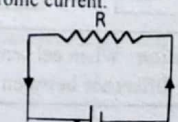
## Conventional Current:

Equivalent current due to flow of positive charge carriers from high potential to low potential is called conventional current.



## Electronic current:

Current due to flow of electrons (negative charge carriers) from low potential to high potential is called electronic current.



یاد رکھیں

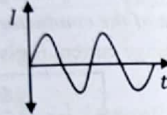
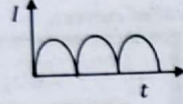
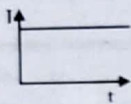
جب بھی ہم electronic current کی بات کرتے ہیں تو اس سے مراد Conventional Current ہوتا ہے۔

**Other Types of Current:**

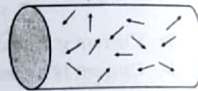
(i) Steady current (D.C)

(ii) Pulsating (D.C)

(iii) Alternating Current (A.C)

**Current through metallic conductor:**

- In metallic conductors charge carriers are free electrons.
- Free electrons are in state of random motion like gas molecules, electrons collide with each other and with lattice atoms and thus they change their direction.
- Thermal velocity of electrons is several 100 km/s
- **When no potential difference is applied across conductor**
  - Average velocity of electrons is zero.
  - Net flow of electrons is zero.
  - Current through conductor is zero.
- **When p.d. is applied across the conductor.**
  - An electric field is produced in the conductor which exerts force on electrons in opposite direction of electric field.
  - Electrons are still in state of random motion but flow of electrons towards high potential (+ve) is greater than flow of electrons towards low potential (-ve) and thus net flow is not zero.
  - Electrons are drifted towards high potential and an electric current passes through conductor.

**Drift velocity:**

Average velocity gained by electrons when a potential difference is applied across the conductor is called drift velocity.

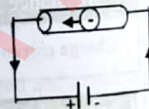
- Drift velocity is of the order of  $10^{-3} \text{ m/s}$  or  $1 \text{ mm s}^{-1}$
- Drift velocity of electrons is always opposite to direction of electric field.

$$V_d = \frac{I}{neA}$$

OR

$$V_d = \frac{V}{RneA}$$

(n is number of charge carriers per unit volume)



**Information:** When eel senses danger, it turns itself into a living battery. The potential difference between head and tail of an electric eel can be up to 600V.

**Source of current:**

A device which maintains a constant potential difference across the two ends of a conductor is called source of current. Source of current converts some non-electrical energy into electrical energy.

**Ideal current source:**

A current source which maintains a constant current irrespective of load resistance is called ideal current source. Its internal resistance is infinite.

Source of current	Cell / Battery	Generator	Thermocouple	Solar cell
Converts	Chemical energy into electrical energy	Mechanical energy into electrical energy	Heat energy into electrical energy	Light energy into electrical energy

**Ideal voltage source:**

A voltage source whose output voltage is independent of current drawn from it is called ideal voltage source. Its internal resistance is zero.

یاد رکھیں

- کسی بھی conductor میں current گزرنے کے لیے تین شرطیں ہیں:
- Conductor میں charge carriers ضروری ہیں۔
  - Conductor کے across پوٹینشل difference ہونا ضروری ہے۔

**EFFECTS OF CURRENT****Heating effect:**

- Current passing through a conductor produces heat in the conductor.
- When current passes through conductor electrons collide with atoms and transfer some energy to atoms thus average K.E of atoms increases and temperature of conductor increases.
- **Applications:** Electric heater, electric stove, electric kettle, electric iron, filament bulb, toaster etc.

**Joule's law of heating:**

When current I is passing through conductor of resistance R for time t then heat produced in conductor is given as

$$H = I^2 R t$$

دلچسپ معلومات

جن devices میں current زیادہ گزرتا ہے ان کے ساتھ کم Resistance والی موٹی تاریں لگاتے ہیں تاکہ ان میں کم heat پیدا ہو اور وہ burn نہ ہوں۔

**Magnetic effect:**

- Current produces through the conductor produces magnetic field around the conductor.
- Strength of magnetic field depends upon amount of current.
- Pattern of magnetic field depends upon shape of conductor.
- Applications: Voltmeter, ammeter, galvanometer, motors, electromagnets, speaker etc.

**Chemical effect:**

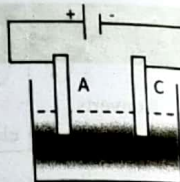
Current passing through electrolyte produces chemical changes in it.

**Electrolytes:** liquids which can conduct electricity are called electrolytes.

**Electrodes:** rods, plates or wires which load current into electrolyte and out of electrolyte are called electrodes:

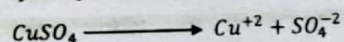
**Anode:** Electrode connected to +ve terminal of battery.

**Cathode:** Electrode connected to -ve terminal of battery.

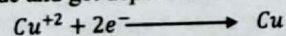


**Voltmeter:** vessel containing the electrolyte and electrodes is called voltmeter.

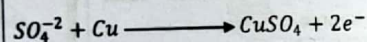
- When  $\text{CuSO}_4$  is dissolved in water it splits up into  $\text{Cu}^{+2}$  and  $\text{SO}_4^{-2}$  ions.



**At Cathode:**  $\text{Cu}^{+2}$  ions move towards the cathode and get deposit there



**At Anode:**  $\text{SO}_4^{-2}$  ions move towards the anode and remove one cell atom of anode.



**Electroplating:** Process of coating a thin layer of some expensive metal on an article of cheap metal is called electroplating.

یاد رکھیں جس metal کو dissolve کرنا ہے اس کا anode اور جس پر deposit کرنا ہے اس cathode بنائیں گے۔

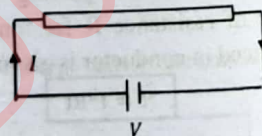
**OHM'S LAW**

"Current passing through conductor is directly proportional to potential difference applied across the conductor provided that physical conditions (Area, length, volume, temperature, strain etc) are constant"

$$I \propto V \text{ or } I = \frac{V}{R}$$

$$\Rightarrow V = IR$$

Where R is constant and known as resistance of conductor.

**Resistance:**

Resistance is measure of opposition in the flow of electrons due to their continuous bumping with atoms of the lattice.

$$R = \frac{V}{I}$$

Resistance of a conductor is independent of applied voltage and current passing through the circuit.

➤ SI unit of resistance is ohm ( $\text{ohm} = \frac{\text{volt}}{\text{ampere}}$ )

➤ Resistance is one ohm if one ampere current passes through conductor in one second.

➤ In terms of base units the unit of resistance is  $\text{kgm}^2\text{s}^{-3}\text{A}^{-2}$

(dimensions =  $[ML^2T^{-3}A^{-2}]$ )

**Ohmic Devices:**

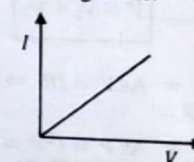
Devices which obey the Ohm's law are called ohmic devices.

- Conductance is reciprocal of resistance

$$\text{Conductance} = \frac{1}{\text{resistance}}$$

- Resistance and conductance of an ohmic device remains constant.
- Resistors and metallic wires for constant temperature are ohmic.

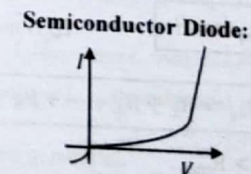
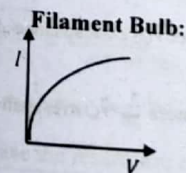
I-V graph for Ohmic devices is a straight line.



Slope of I-V graph represents the conductance.

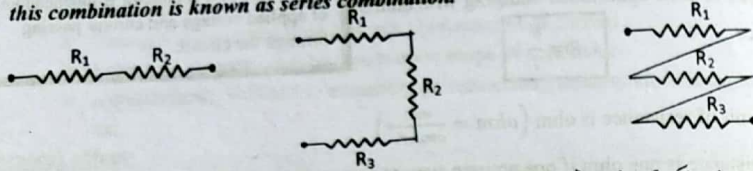
**Non-Ohmic Devices:**

- Devices which do not obey Ohm's law are called non-ohmic devices.
- I-V graph for non-ohmic devices is not a straight line (non-linear).
- Slope of I-V graph represent the conductance.
- Resistance and conductance of a non-ohmic device does not remains constant.
- Filament bulb, diodes, discharge tubes, transistors, capacitors, inductor etc. are non-ohmic devices.



**1. Series combination:**

If resistors are connected end to end such that same current is passing through all of them this combination is known as series combination.



(اگر resistors ایک ہی path میں connected ہوں تو resistors سیریز میں ہوں گے)

> Current passing through each resistor is same  $I_1 = I_2 = I$  and  $\frac{I_1}{I_2} = 1$

$$I_1 = I_2 = \frac{V}{R_{eq}}$$

> Voltage is divided among the resistors

$$V = V_1 + V_2$$

★ As  $V = IR \Rightarrow V \propto R$  (جس کی resistance زیادہ ہوگی اس کے across voltage بھی زیادہ drop ہوگا)

★ As  $P = I^2 R \Rightarrow P \propto R$  (جس کی resistance زیادہ ہوگی اس میں Power بھی زیادہ خرچ ہوگی)

**Voltage Divider Rule:**

If two resistance  $R_1$  and  $R_2$  are in series with voltage  $V$  then

$$V_1 = \frac{R_1}{R_1 + R_2} V \quad \text{and} \quad V_2 = \frac{R_2}{R_1 + R_2} V$$

**Example:** Two resistances  $R_1 = 2\Omega$  and  $R_2 = 4\Omega$  are connected in series with a 12V battery then voltage drop across  $4\Omega$  resistor will be  
(a) 2V (b) 4V (c) 6V (d) 8V

**Solution:**  $V_2 = \frac{R_2}{R_1 + R_2} V$   
 $= \frac{4}{2 + 4} \times 12 = 8V$

**Equivalent Resistance:**

If 'n' number of resistors are connected in series then

1.  $R_{eq} = nR$  (اگر سب سے پہلے دیکھیں کہ resistance برابر ہیں تو resistance کو تعداد سے multiply کر دیں)

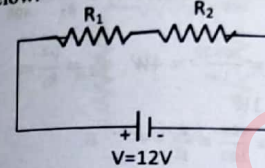
2.  $R_{eq} = R_1 + R_2 + \dots + R_n$  (اگر مختلف values والی resistance ہوں تو سب resistances کا sum کر دیں)

3.  $R_{eq} > R_{max}$

4. To increase the resistance, resistors are connected in series.

**Example:**

If two resistors  $R_1 = 2\Omega$  and  $R_2 = 4\Omega$  are connected in series as shown in the figure below:



$$1. R_{eq} = R_1 + R_2 = 2 + 4 = 6\Omega$$

$$2. I = I_1 = I_2 = \frac{V}{R_{eq}} = \frac{12}{6} = 2A$$

$$3. V_1 = \frac{R_1}{R_1 + R_2} V = \frac{2}{2+4} (12) = \frac{2}{6} (12) = 4V$$

$$4. V_2 = \frac{R_2}{R_1 + R_2} V = \frac{4}{2+4} (12) = \frac{4}{6} (12) = 8V$$

$$5. \frac{V_1}{V_2} = \frac{R_1}{R_2} = \frac{2}{4} = \frac{1}{2}$$

$$6. \frac{I_1}{I_2} = \frac{2}{2} = 1$$

$$7. P_1 = I^2 R_1 = (2)^2 (2) = 4 \times 2 = 8W$$

$$P_2 = I^2 R_2 = (2)^2 (4) = 4 \times 4 = 16W$$

**Parallel Combination:**

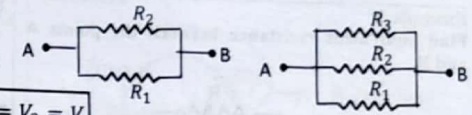
If resistors are connected side by side such that same P.d is applied across all of them then this combination is known as parallel combination.

> Voltage across each resistor is same.  $V_1 = V_2 = V$

> Current is divided  $I = I_1 + I_2$

★ As  $I = \frac{V}{R} \Rightarrow I \propto \frac{1}{R}$  (جس کی resistance زیادہ ہوگی اس میں سے کرنٹ کم گزرے گا)

★ As  $P = \frac{V^2}{R} \Rightarrow P \propto \frac{1}{R}$  (جس کی resistance زیادہ ہوگی اس میں Power کم خرچ ہوگی)

**Current Divider Rule:**

If two resistors  $R_1$  and  $R_2$  are connected in parallel with total current  $I$  then current through each resistor is given as

$$I_1 = \frac{R_2}{R_1 + R_2} I \quad \text{and} \quad I_2 = \frac{R_1}{R_1 + R_2} I$$

**Equivalent Resistance:**

If 'n' number of resistors are connected in series then

1.  $R_{eq} = \frac{R}{n}$  (اگر سب سے پہلے دیکھیں کہ resistors برابر values والے ہیں تو تعداد پر divide کر دیں)

2.  $R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{\text{product of resistances}}{\text{sum of resistance}}$  (اگر دو مختلف values والے resistors ہوں)

3.  $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$  (اگر زیادہ values different والے capacitor ہوں تو اس فارمولے کو use کریں)

4. To decrease the resistance, resistors are connected in parallel.

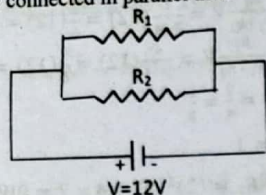
$$R_{series} = n^2 R_{parallel}$$

$R_{series}$  = Equivalent resistance when resistors are connected

$R_{parallel}$  = Equivalent resistance when resistors are connected in parallel.

**Example:**

If two resistors  $R_1 = 100\Omega$  and  $R_2 = 400\Omega$  are connected in parallel then

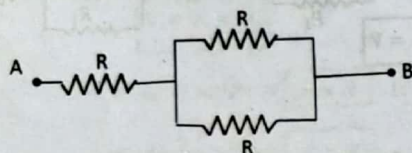


1.  $R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{100 \times 400}{500} = 80\Omega$
2.  $V_1 = V_2 = V = 20V$
3.  $I_1 = \frac{V}{R_1} = \frac{20}{100} = 0.2A$ ,  $I_2 = \frac{V}{R_2} = \frac{20}{400} = 0.05A$
4.  $P_1 = \frac{V^2}{R_1} = \frac{20 \times 20}{100} = 4W$ ,  $P_2 = \frac{V^2}{R_2} = \frac{20 \times 20}{400} = 1W$
5.  $\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{400}{100} = 4$
6.  $\frac{V_1}{V_2} = \frac{R_1}{R_2} = \frac{100}{400} = \frac{1}{4}$

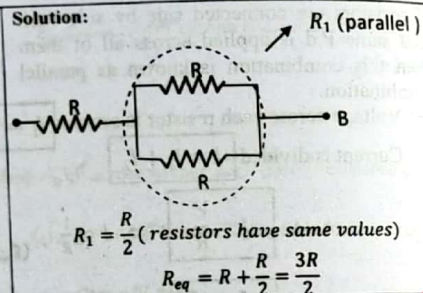
## PRACTICE EXAMPLES

**Example 1:**

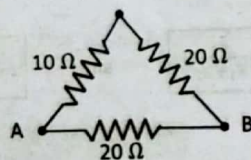
Find equivalent resistance between the points A and B



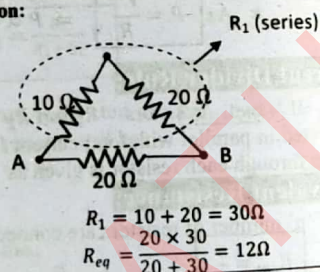
Solution:

**Example 2:**

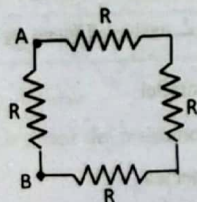
Find equivalent resistance between the points A and B



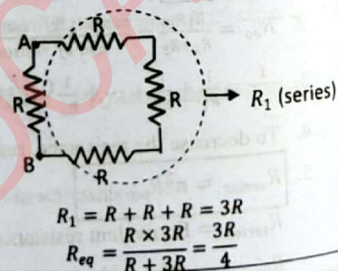
Solution:

**Example 3:**

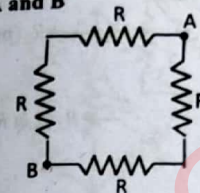
Find equivalent resistance between the points A and B



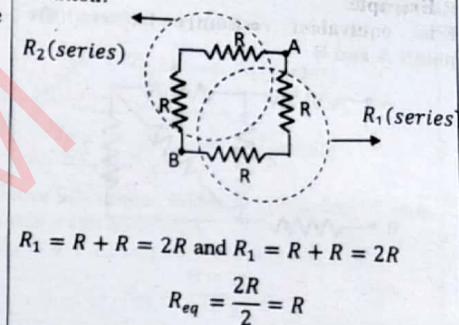
Solution:

**Example 4:**

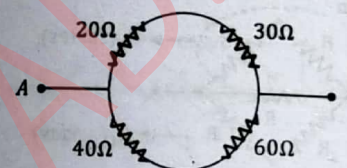
Find equivalent resistance between the points A and B



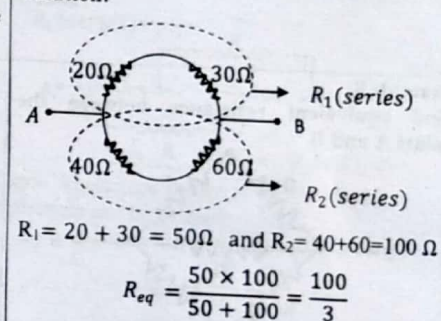
Solution:

**Example 5:**

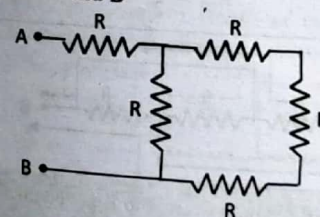
Find equivalent resistance between the points A and B



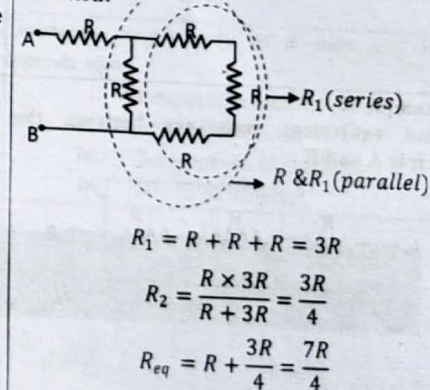
Solution:

**Example 6:**

Find equivalent resistance between the points A and B

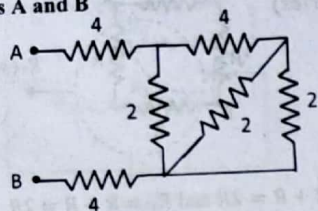
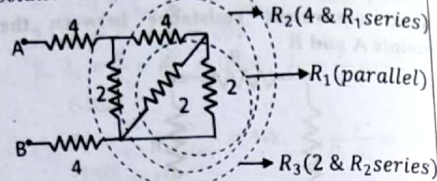


Solution:



**Example 7:**

Find equivalent resistance between the points A and B

**Solution:**

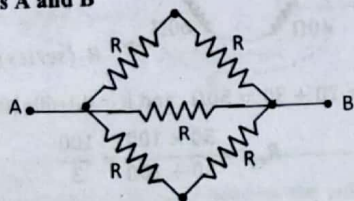
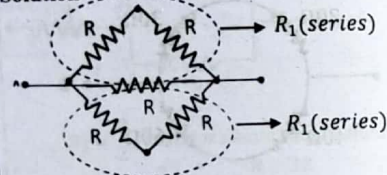
$$R_1 = \frac{2}{2} = 1 \text{ and } R_2 = 1 + 4 = 5$$

$$R_3 = \frac{2 \times 5}{2 + 5} = \frac{10}{7}$$

$$R_{eq} = 4 + 4 + \frac{10}{7} = \frac{66}{7}$$

**Example 8:**

Find equivalent resistance between the points A and B

**Solution**

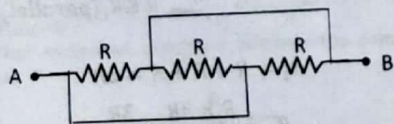
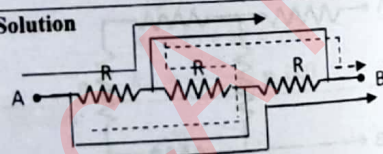
$$R_1 = R + R = 2R \text{ and } R_2 = R + R = 2R$$

$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{2R} + \frac{1}{2R}$$

$$R_{eq} = \frac{R}{2}$$

**Example 9:**

Find equivalent resistance between the points A and B

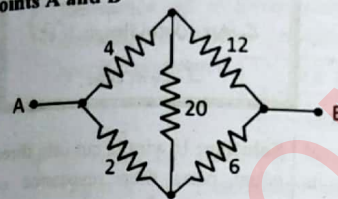
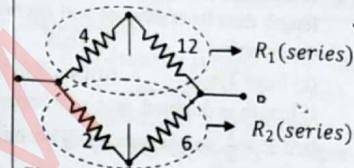
**Solution**

There are three paths from A to B hence three resistors are in parallel

$$R_{eq} = \frac{R}{3} \text{ (resistors have same value)}$$

**Example 10:**

Find equivalent resistance between the points A and B

**Solution**

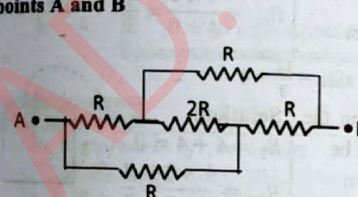
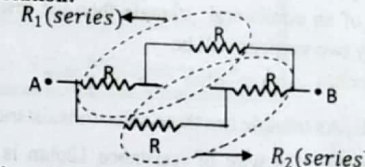
Since Wheatstone bridge is satisfied so 20 ohm resistor can be deleted

$$R_1 = 4 + 12 = 16 \text{ and } R_2 = 2 + 6 = 8$$

$$R_{eq} = \frac{8 \times 16}{8 + 16} = \frac{16}{3}$$

**Example 11:**

Find equivalent resistance between the points A and B

**Solution:**

Since Wheatstone bridge is satisfied so 2R resistance can be deleted

$$R_1 = R + R = 2R \text{ and } R_2 = R + R = 2R$$

$$R_{eq} = \frac{2R}{2} = R$$

## TEMPERATURE DEPENDENCE OF RESISTIVITY

**Resistance:**

It is found that resistance of a conductor is directly proportional to length of conductor and inversely proportional to cross-sectional area of the conductor

$$R \propto \frac{L}{A}$$

or

$$R = \frac{\rho L}{A}$$

Resistance is property of a wire and it depends upon.

- Length of conductor
- Area of conductor
- Temperature of conductor
- Nature of material

Relation with length of wire	Relation with area of wire	Relation with radius of wire	Relation with diameter of wire
$R \propto L$	$R \propto \frac{L}{A}$	$R \propto \frac{1}{r^2}$	$R \propto \frac{1}{d^2}$

**Example:** If a wire is stretched to twice of its length then its resistance will become

- (a) Double (b) Half  
(c) Four Times (d) One Fourth

**Solution:** If length is doubled, area will become half  $R \propto \frac{L}{A}$  so resistance will become 4-times

**Example:** If a wire of resistance R is cut into three equal parts and these parts are connected in parallel then its equivalent resistance will become

- (a) R (b)  $\frac{R}{3}$  (c)  $\frac{R}{9}$  (d) 3R

**Example:** If a wire of resistance 12 ohm is bent along the sides of an equilateral triangle then the resistance between its any two vertices will be

- (a) 6 ohm (b)  $\frac{4}{3}$  ohm (c)  $\frac{8}{3}$  ohm (d) 4 ohm

**NOTE:** As triangle has three sides so resistance of each side =  $\frac{12}{3} = 4$

**Example:** If a wire of resistance 12 ohm is bent along the sides of a square then the resistance along diagonal will be

- (a) 6 ohm (b)  $\frac{4}{3}$  ohm (c)  $\frac{8}{3}$  ohm (d) 4 ohm

**NOTE:** As square four sides so resistance of each side =  $\frac{12}{4} = 3$

**Example:** If a wire of resistance 20 ohm is bent along the circle then the resistance along diameter will be

- (a) 6 ohm (b)  $\frac{4}{3}$  ohm (c)  $\frac{8}{3}$  ohm (d) 4 ohm

### Conductance:

- Reciprocal of resistance is called conductance

$$G = \frac{1}{R} = \frac{A}{\rho L}$$

- Unit of conductance is  $\text{ohm}^{-1}$  or mho or simen

Conductance is property of a wire and it depends upon.

- Length of conductor
- Area of conductor
- Temperature of conductor
- Nature of material

Relation with length of wire	Relation with area of wire	Relation with radius of wire	Relation with diameter of wire
$G \propto \frac{1}{L}$	$G \propto A$	$G \propto r^2$	$G \propto d^2$

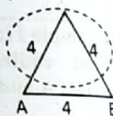
یاد رکھیں جب wire کو stretch کریں گے تو جتنے کا length زیادہ ہوگی Area اتنے time کم ہو جائے گا۔

**Solution:** If wire is cut into three equal parts then resistance of each part is  $\frac{R}{3}$  by connecting in parallel  $R_{eq} = \frac{R/3}{3} = \frac{R}{9}$

**Solution:**

$$R_1 = 4 + 4 = 8$$

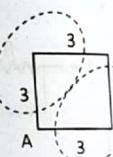
$$R_{eq} = \frac{4 \times 8}{4 + 8} = \frac{8}{3}$$



**Solution:**

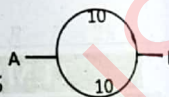
$$R_1 = 4 + 4 = 8$$

$$R_{eq} = \frac{4 \times 8}{4 + 8} = \frac{8}{3}$$



**Solution:**

$$R_{eq} = \frac{10}{2} = 5$$



### Resistivity or Specific Resistance:

- Resistance of a meter cube of a material is called resistivity or specific resistance.

$$\rho = \frac{RA}{L}$$

- SI unit of resistivity is ohm-m ( $\text{kgm}^3\text{s}^{-3}\text{A}^{-2}$ ) and dimensions are  $[ML^3T^{-3}A^{-2}]$

#### Dependence:

- Resistivity is property of material and it is independent of length, area or dimensions of conductor.  
➤ Resistivity only depends upon temperature and nature of material.

یاد رکھیں

Resistivity ایک proportionality کا نسبت ہے اور کسی بھی فارمولے میں proportionality کا نسبت اس فارمولے کی باقی quantities پر depend نہیں کرتا۔

### Conductivity:

- Reciprocal of resistivity is called conductivity.

$$\sigma = \frac{1}{\rho} = \frac{L}{RA}$$

- Its SI unit  $\text{ohm}^{-1}\text{m}^{-1}$  ( $\text{kg}^{-1}\text{m}^{-3}\text{s}^3\text{A}^2$ )

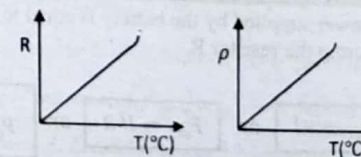
#### Dependence:

- Conductivity is property of material and it is independent of length, area or dimensions of conductor.  
➤ Conductivity only depends upon temperature and nature of material.

### Temperature dependence:

By increasing temperature, average K.E of atoms increases due to which the amplitude of vibrations of atoms increases thus probability of collisions of electrons with atoms increases. Since resistance is due to collision of electrons with atoms hence resistivity or resistance of conductor increases by increasing temperature.

- Resistance or resistivity of metals increase linearly with temperature.



**Temperature Coefficient of Resistance:**

Fractional change in resistance per Kelvin is called temperature coefficient of resistance.

$$\alpha = \frac{R_t - R_0}{R_0 t}$$

- Its SI unit is  $K^{-1}$ .
- It only depends upon nature of material.

- For all metals (Cu, Al, Fe etc.)  $\alpha$  is positive which means by increasing temperature their resistance increases (conductance decreases).
- For semi-conductors insulators and electrolytes (C, Si, Ge)  $\alpha$  is negative which means by increasing temperature their resistance decreases (and conductance increases)

**Temperature Coefficient of Resistivity:**

Fractional change in resistivity per Kelvin is called temperature coefficient of resistivity.

$$\alpha = \frac{\rho_t - \rho_0}{\rho_0 t}$$

- Its SI unit is  $K^{-1}$ .

یاد رکھیں

$\alpha$  کی value بہت زیادہ ہونے کا مطلب ہے کہ اگر temperature میں تھوڑا سا change آئے تو Resistance میں بہت زیادہ Change آئے گا۔

**Electrical Power****Electrical power:**

"Energy supplied by cell or battery per unit time is called electrical power of the battery or cell."

$$P = \frac{\text{Energy supplied}}{\text{Time}}$$

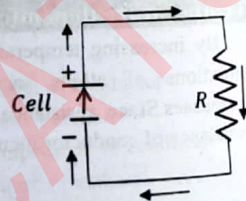
or

$$P = VI$$

Charge  $\Delta q$  move from high potential to low potential and dissipates its energy across resistance  $R$  and comes to low potential. Battery supplies the energy to charge and move it from low potential to high potential.

**Power dissipated across resistor:**

Power supplied by the battery is equal to power dissipated across the resistor  $R$



$$P_{dis} = VI \quad \text{or} \quad P_{dis} = I^2 R \quad \text{or} \quad P_{dis} = \frac{V^2}{R}$$

اگر resistor میں گئے ہوں تو  $P = I^2 R$  اور  
اگر resistor میں گئے ہوں تو  $P = \frac{V^2}{R}$  کو prefer کریں۔

**Series Combination of Power:**

If 'n' number of devices are connected in series then,

$$1. \quad P_{eq} = \frac{P}{n}$$

(سب سے پہلے دیکھیں اگر device کی ولٹیجز same ہوں تو Power کو تعداد پر divide کریں۔)

$$2. \quad P_{eq} = \frac{P_1 P_2}{P_1 + P_2} = \frac{\text{product of power}}{\text{sum of power}}$$

(اگر دو different value کے devices ہوں تو یہ فارمولا use کریں۔)

$$3. \quad \frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2} + \dots + \frac{1}{P_n}$$

(اگر زیادہ value کے devices ہوں تو یہ فارمولا use کریں۔)

$$4. \quad P_{eq} < P_{min}$$

(series میں اگر کوئی ایک device بھی off ہو جائے تو باقی سب بھی off ہو جائیں گے)

5. To decreases the power devices are connected in series.

**Example:** Two filament bulbs having power rating 100 W are connected in series as shown in the figure below. Then equivalent power will be?

- (a) 70 W (b) 150 W (c) 240 W (d) 300 W

$$\text{Solution: } P_{eq} = \frac{P_1 P_2}{P_1 + P_2} = \frac{100 \times 100}{100 + 100} = \frac{100 \times 100}{200} = \frac{100}{2} = 50 \text{ W}$$

**Parallel Combination:**

If 'n' number of devices are connected in parallel then

$$P_{eq} = nP$$

(سب سے پہلے دیکھیں اگر device کی ولٹیجز same ہوں تو Power کو تعداد سے multiply کریں۔)

$$1. \quad P_{eq} = P_1 + P_2 + \dots + P_n$$

(اگر دو different value کے devices ہوں تو سب کی power کا sum کریں۔)

$$P_{eq} > P_{max}$$

2. To increase the power devices are connected in parallel.

**Example:** Two filament bulbs having power rating 200 W and 500 W are connected in parallel Then equivalent power will be about?

- (a) 140 W (b) 250 W (c) 350 W (d) 700 W

Solution:

$$P_{eq} = P_1 + P_2 = 200 + 500 = 700 \text{ W}$$

یاد رکھیں

1. ہمارے گھر میں تمام devices جو ال میں لگے ہوتے ہیں اور سب کو ملنے والا voltage برابر ہوتا ہے۔

2. تمام devices پر power rating ہمیشہ جو ال کے مطابق ہوتی ہے۔

3. جس device کی power زیادہ ہوتی ہے اس کی resistance کم ہوتی ہے۔

مثال کے طور پر زیادہ power والا filament bulb filament بنانے کے لیے filament کی resistance کم ہونی چاہئے یعنی thick filament بنانا چاہئے۔

$$P \propto \text{thickness of filament}$$

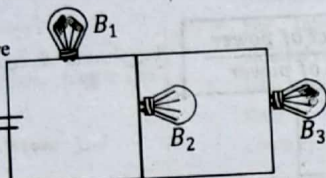
$$P = VI \text{ or } P \propto I$$

4. جس device کی power زیادہ ہوگی وہ current بھی زیادہ draw کر لے گا۔

Parallel میں کوئی device add کرنے سے یا remove کرنے سے on / off کرنے سے یا burn (open circuit) ہو جانے سے parallel میں لگے باقی devices پر کوئی فرق نہیں پڑتا۔

**Example:**

If three bulb  $B_1$ ,  $B_2$  and  $B_3$  are connected with a battery as shown in the figure. If  $B_1$  is burnt then what is effect on brightness of  $B_2$  and  $B_3$ .



- (a) increases (b) decreases (c) remain same (d) become zero

**Solution:**

If  $B_1$  is burnt then it will break the circuit and stop the flow of current thus brightness of  $B_2$  and  $B_3$  becomes zero.

اگر  $B_1$  burn ہو جائے تو current کا flow بند ہو جائے گا۔ جس کی وجہ سے  $B_2$  or  $B_3$  بھی بند ہو جائیں گے۔  
اگر  $B_2$  burn ہو جائے تو  $B_3$  کی brightness پر کوئی فرق نہیں پڑے گا لیکن circuit کی equivalent resistance زیادہ ہونے کی وجہ سے total current کم ہو جائے گا اور  $B_1$  کی brightness کم ہو جائے گی۔

کوئی بھی device add کرنے سے یا remove کرنے سے series میں لگے device پر ہمیشہ فرق پڑے گا۔  
اگر  $R_{eq}$  بڑھ جائے تو total current کم ہو جائے گا اور brightness کم ہو جائے گی۔  
اگر  $R_{eq}$  بڑھ جائے تو total current کم ہو جائے گا اور brightness زیادہ ہو جائے گی۔

**ELECTROMOTIVE FORCE**

Energy supplied by battery per unit charge is called electromotive force or EMF of battery.

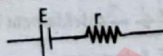
$$EMF = \frac{\text{Energy supplied}}{\text{Charge}}$$

- It is a scalar quantity.
- Its SI unit is volt ( $Jc^{-1} = kgm^2s^{-3}A^{-1}$ )
- Its dimensions are  $[ML^2T^{-3}A^{-1}]$

**Internal Resistance:**

Resistance due to presence of electrolyte between the electrodes is called internal resistance. It is denoted by ' $r$ '.

- EMF and internal resistance act in series.



- Internal resistance of an ideal voltage source is zero.

**Dependence:**

- Distance between electrodes ( $r \propto d$ ).
- Area between electrodes ( $r \propto \frac{1}{A}$ ).
- Nature or concentration of electrolyte.
- Temperature

یاد رکھیں Battery کو Coulomb چارج کو بتاتی Energy مہیا کرتی ہے وہ EMF کہلاتی ہے۔ مثال کے طور پر 12V کی Battery کو Coulomb چارج کو 12J انرجی مہیا کرے گی۔

**Three Important Cases:****1. Closed Circuit:**

Consider an external resistance  $R$  is connected across a battery of EMF ' $E$ ' and internal resistance ' $r$ '.

- Current drawn from the battery is

$$I = \frac{E}{r+R}$$

- Potential drop across external resistance or terminal Potential difference is

$$V_t = IR$$

- Potential drop across internal resistance is ' $Ir$ '.

- Equation of cell/battery when it is discharging is  $E = V_t + Ir$  and ( $V_t < E$ )

- Power dissipated in external resistance is  $P = V_t I = I^2 R = \frac{V_t^2}{R} = \frac{E^2 R}{(r+R)^2}$

- Output power drawn from battery is maximum when  $R=r$  (internal resistance = external resistance)

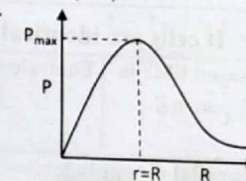
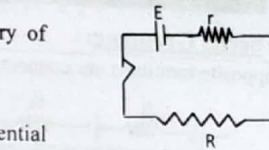
$$P_{max} = \frac{E^2}{4r}$$

$$P_{max} = \frac{E^2}{4R}$$

- Current drawn from battery is maximum when  $R=r$

$$I_{max} = \frac{E}{2r}$$

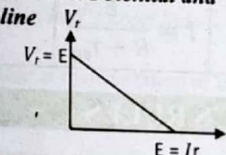
$$I_{max} = \frac{E}{2R}$$



**NOTE:** when battery is being charged i.e current is given to battery then

$$V_r = E + Ir \text{ and } V_r > E$$

The graph between Terminal Potential and current is a straight line



For x-intercept  $V=0$

$$\text{So } E = Ir \text{ or } r = \frac{E}{I}$$

For y-intercept  $I=0$

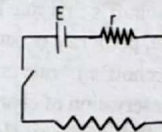
$$V_t = E$$

گراف سے EMF اور Internal resistance دونوں معلوم کیے جاسکتے ہیں۔

**2. Open Circuit:**

When no current is being drawn from battery or cell it is said to be open circuit.

- Current through circuit = 0
- Terminal potential difference is equal to ( $V_t = E$ ).
- Potential drop across internal resistance and external resistance is zero.  $R$

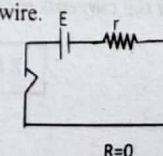
**3. Closed Circuit:**

When two terminals of cell or battery are joined together by thick wire.

- Maximum current is drawn from battery

$$I_{max} = \frac{E}{r}$$

- Terminal potential difference is zero ( $V = 0$ ).

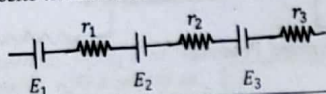


$R=0$

## GROUPING OF CELLS

## 1. Series Grouping:

If opposite terminals are connected with each other.



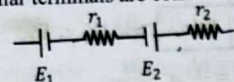
Equivalent EMF is given as

$$E_{eq} = E_1 + E_2 + E_3$$

Equivalent internal resistance is given as

$$r_{eq} = r_1 + r_2 + r_3$$

If similar terminals are connected with each other.



Equivalent EMF is given as

$$E_{eq} = E_1 - E_2$$

Equivalent internal resistance is given as

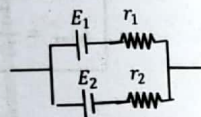
$$r_{eq} = r_1 + r_2$$

## ➤ If cells are identical

Equivalent EMF is	Equivalent internal resistance	Current	Power
$E_{eq} = nE$	$r_{eq} = nr$	$I = \frac{E_{eq}}{R + r_{eq}}$	$P_{max} = n\left(\frac{E^2}{4r}\right)$

## 2. Parallel Grouping:

If similar cathodes terminals are connected together at one point and anodes are connected together at other point.



Equivalent EMF is	Equivalent internal resistance	Total Current	Current through each cell
$E_{eq} = E$	$r_{eq} = \frac{r}{n}$	$I = \frac{E}{R + r_{eq}}$	$I_n = \frac{I}{n}$

## KIRCHOFF'S RULES

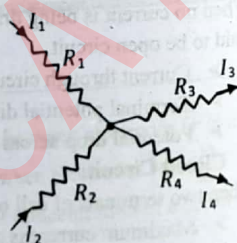
## 1. Kirchhoff's First Rule:

- Kirchhoff's first rule is also known as Kirchhoff's current rule, point rule or junction rule.
- Kirchhoff's 1<sup>st</sup> rule is manifestation of law of conservation of charge.

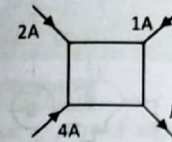
"Sum of all the currents flowing towards a point is equal to sum of all the currents flowing away from point."

"sum of all the currents meeting at a point is equal to zero"

$$\Sigma I = 0$$



Example: Figure shows a network of current. Then the current I will be



- (a) 1A (b) 3A (c) 5A (d) 7A

Solution:

Total incoming current = 2 + 4 + 1 = 7A

Total outgoing current = 7A OR

"Sum of all the currents meeting at point is equal to zero"  $\Sigma I = 0$

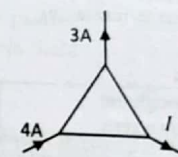
$$2A + 4A + 1A - I = 0 \Rightarrow I = 7A$$

sign convention	Incoming current	Outing current
	+ve	-ve

Example:

Figure shows a network of currents then current I will be

- (A) 1A (B) 4A  
(C) 5A (D) 7A



Solution:

$$4 - 3 - I = 0$$

$$\Rightarrow I = 1A$$

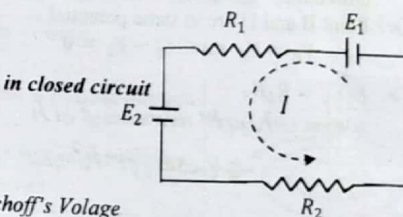
## 2. 2nd Rule:

"Algebraic sum of all potential changes in closed circuit is equal to zero"

$$\Sigma V = 0$$

- Kirchhoff's 2<sup>nd</sup> Rule is also known as Kirchhoff's Voltage Rule (KVL) and Kirchhoff's Loop Rule.

- Kirchhoff's 2<sup>nd</sup> Rule is manifestation of law of conservation of energy.



$$+E_1 - IR_1 - E_2 - IR_2 = 0$$

FOR BATTERY		FOR RESISTORS	
Traversing from -ve to +ve	Traversing from +ve to -ve	Traversing in direction of current	Traversing in opposite direction of current

**Wheatstone:**

Wheatstone bridge is a circuit which is used to determine unknown resistance of a wire.

Its circuit diagram is shown in the figure:

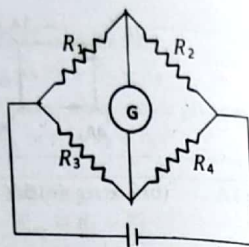
**Balancing Condition**

$$1. \frac{R_1}{R_2} = \frac{R_3}{R_4} \text{ or } \frac{R_1}{R_3} = \frac{R_2}{R_4}$$

نسبتیں برابر ہونی چاہئے ratio Adjacent resistances

$$2. R_1 R_4 = R_2 R_3$$

Product Opposite resistances برابر ہونا چاہئے

**Under Balancing Condition**

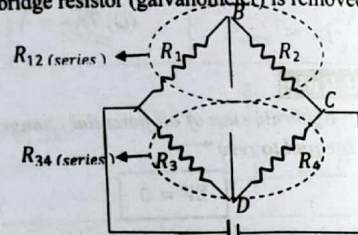
- No current passes through the galvanometer and shows zero deflection.
- Point B and D are at same potential.  
 $V_B = V_D$  and  $V_B - V_D = 0$

$$\text{➤ } R_1 R_4 = R_2 R_3$$

اگر کوئی تین معلوم ہوں تو اس relation سے چوتھی کو معلوم کر سکتے ہیں۔ چاہئے

ہے چوتھی کو معلوم کر سکتے ہیں۔ چاہئے

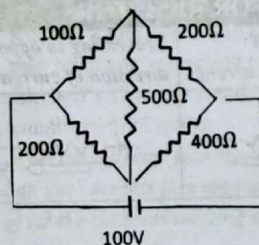
To find equivalent resistance of the circuit bridge resistor (galvanometer) is removed



$R_{12}$  and  $R_{34}$  are in parallel

**Example:**

Five resistors are connected with a 100V battery as shown in the figure below:



$$\text{Solution: } R_1 R_4 = R_2 R_3 \\ \Rightarrow 100 \times 400 = 200 \times 200 \\ 400 = 400$$

- Balancing condition is satisfied
- No current passes through 500Ω resistance.

$$V_B = V_D \text{ or } V_B - V_D = 0$$

**Equivalent resistance:**

$$R_{12} = 100 + 200 = 300 \text{ and } R_{34} = 200 + 400 = 600 \\ R_{eq} = \frac{300 \times 600}{300 + 600} = 200\Omega$$

**UNIT 08 >>****ELECTROMAGNETISM****Electromagnetism:**

- Branch of physics which deals with study of magnetic effects produced by motion of charges is called **electromagnetism**.

- If a magnetic compass is placed near current carrying conductor, the magnetic field will deflect its direction.

- In 1820 Orested discovered that current passing through a conductor produces magnetic field around the conductor

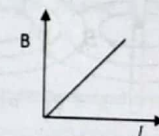
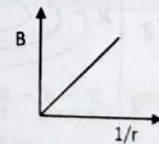
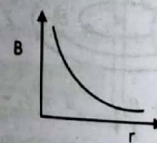
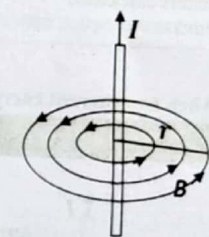
**Note:** When a steady current is passing through a conductor then

Inside the conductor	Outside the conductor
$E \neq 0$ but $B = 0$	$B \neq 0$ but $E = 0$

**Magnetic Field Due To Current Carrying Straight Conductor**

- Magnetic field produced by current carrying straight conductor is circular (concentric circles)
- Magnetic field lasts only as long as current is passing through conductor.
- If 'I' is current passing through conductor then at any distance 'r' from the conductor magnetic field given as

$$B = \frac{\mu_0 I}{2\pi r} \Rightarrow B \propto I \text{ and } B = \frac{I}{r}$$



Where  $\mu_0 = 4\pi \times 10^{-7} \text{ Wbm}^{-1}\text{A}^{-1}$  and known as permeability of free space.

**Note**

- r is distance from the conductor and it is not radius of wire of conductor.

- Direction of magnetic field depends upon direction of current and it is determined by right hand rule.

"Grasp the conductor in your right hand with thumb pointing in the direction of current then curling fingers represents the direction of magnetic field".

**Short Cut Method**

1. کرنٹ کی طرف اپنا Thumb کریں۔
2. Thumb والے side سے فیلڈ anti-clockwise direction میں ہوگا۔
3. اور دوسری side سے clockwise ہوگا۔

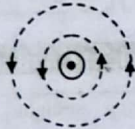
**Current I is out of the plane of paper**

**From above:**

Field is anti-clockwise

**From below:**

Field is clockwise



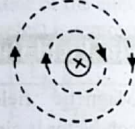
**Current I is out of the plane of paper**

**From above:**

Field is Clockwise

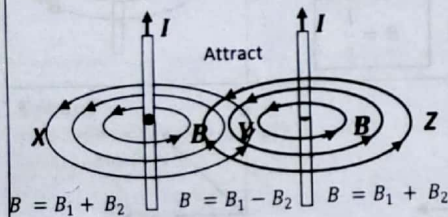
**From below:**

Field is Anti-clockwise



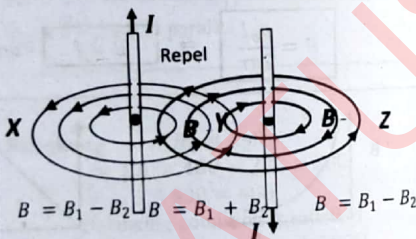
**When two current carrying wires are placed near each other.**

**When current is in same direction**



- Wires attract each other.
- Since direction of force is always from strong field to weak. Hence
- Field is strong at X and Z  
( $B_{net} = B_1 + B_2$ )
- Field is weak at Y  
( $B_{net} = B_1 - B_2$ )

**When current is in opposite direction**



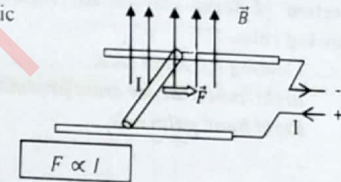
- Wires repel each other.
- Since direction of force is always from strong field to weak. Hence
- Field is strong at Y  
( $B_{net} = B_1 + B_2$ )
- Field is weak at X and Z  
( $B_{net} = B_1 - B_2$ )

## FORCE ON CURRENT CARRYING CONDUCTOR IN A UNIFORM MAGNETIC FIELD

When a current carrying conductor is placed in magnetic field it will experience force given as

$$F = ILB\sin\theta$$

- Force on the conductor is directly proportional to current passing through conductor.  
 $F \propto I$
- Force on the conductor is directly proportional to length of conductor inside the magnetic field  
 $F \propto L$
- Force on the conductor is directly proportional to external magnetic field.  
 $F \propto B$
- Force on the conductor is directly proportional to  $\sin\theta$  where ' $\theta$ ' is angle between magnetic field and direction of current through conductor.  
 $F \propto \sin\theta$

**Magnetic Induction:**

Magnetic induction is defined as magnetic force acting on one meter length of conductor, placed perpendicular to the magnetic field lines when one ampere current is passing through the conductor.

$$B = \frac{F}{IL \sin\theta}$$

- Its SI unit is Tesla ( $T = Nm^{-1}A^{-1} = kgm^{-1}s^{-2}A^{-1}$ )
- Its dimensions are  $[ML^0T^{-2}A^{-1}]$

**Tesla:**

Magnetic induction is one tesla if one newton force is acting on one meter length of conductor placed perpendicular to magnetic field lines when one ampere current is passing through the conductor.

**Vector form:**

Magnetic force on current carrying conductor in vector form is given as

$$\vec{F} = I(\vec{L} \times \vec{B})$$

یاد رکھیں جب بھی دو vectors کا cross product کرتے ہیں تو اس سے بننے والا vector ہمیشہ ان دونوں کے perpendicular ہوتا ہے۔

- Magnetic force is always perpendicular to length of conductor and magnetic field lines  
 $F \perp L$  and  $F \perp B$ .
- Magnetic force is maximum when conductor is placed perpendicular to magnetic field lines.  
 $F_{max} = ILB$
- Magnetic force is zero or minimum when conductor is placed parallel or anti-parallel to magnetic field lines.  
 $F_{min} = ILB\sin 0^\circ = 0$

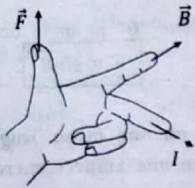
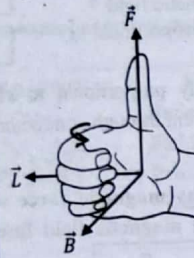
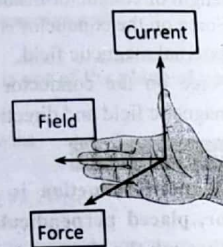
**Direction of Force:**

Direction of force can be determined following rules.

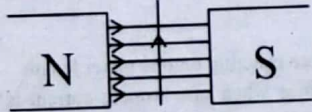
- Fleming left hand rule.**
- Right hand rule for cross product.**
- Right hand palm rule**

**How to Apply Right Hand Palm Rule**

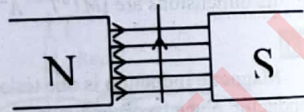
- سب سے پہلے Right hand کا تھمب بتائیں۔
- Fingers کی direction ٹیبلڈ کی طرف set کریں۔
- تھمب کو Rotate کر کے thumb کی direction کرنٹ کی طرف set کریں۔
- تو جس طرف Palm کی direction ہوگی اس طرف Force عمل کرے گی۔

**Fleming left and rule****Right and rule****Right and palm rule****SOME IMPORTANT PRACTICE EXAMPLE FOR RIT AND PALM RULE**

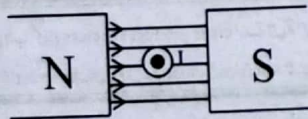
**Example 1:** Find the direction of magnetic force on the current carrying conductor



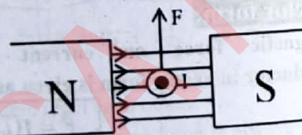
**Answer:** Direction of force is into the plane of paper



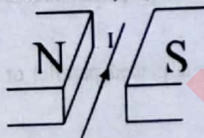
**Example 2:** Find the direction of magnetic force on the current carrying conductor



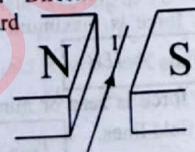
**Answer:** Direction of force is upward



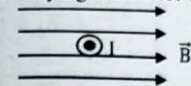
**Example 3:** Find the direction of magnetic force on the current carrying conductor



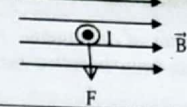
**Answer:** Direction of force is vertically downward



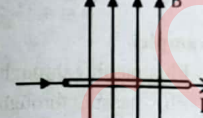
**Example 4:** Find the direction of magnetic force on the current carrying conductor (if I is electronic current)



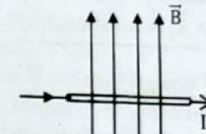
**Answer:** Direction of force is downward



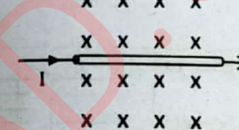
**Example 5:** Find the direction of magnetic force on the current carrying conductor



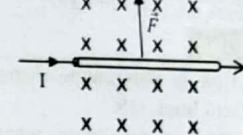
**Answer:** Direction of force is out of plane of paper



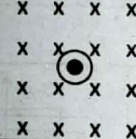
**Example 6:** Find the direction of magnetic force on the current carrying conductor



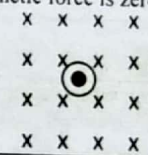
**Answer:** Direction of force is upward



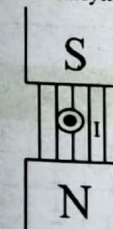
**Example 7:** Find the direction of magnetic force on the current carrying conductor



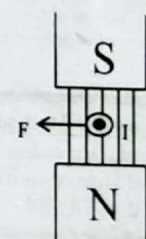
**Answer:** Since current is anti parallel to field line so magnetic force is zero



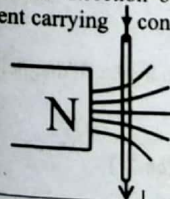
**Example 8:** Find the direction of magnetic force on the current carrying conductor



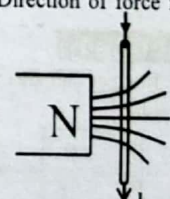
**Answer:** Direction of force towards left



**Example 8:** Find the direction of magnetic force on the current carrying conductor



**Answer:** Direction of force is out of plane of paper



## MAGNETIC FLUX

"Number of magnetic field lines passing through certain area is called magnetic flux through that area."

- Magnetic flux is denoted by  $\Phi_B$  and

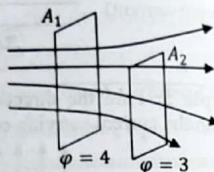
$$\Phi_B = \vec{B} \cdot \vec{A} = BA \cos \theta$$

(Where  $\theta$  is angle between  $\vec{B}$  and vector area)

- It is a scalar quantity.  
➤ Its SI unit is Weber ( $Wb = T \cdot m^2 = NmA^{-1} = kgm^2s^{-2}A^{-1}$ ).  
➤ Its dimensions are  $[ML^2T^{-2}A^{-1}]$ .

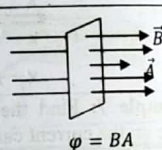
## Maximum Flux:

- Magnetic flux is maximum when vector area is parallel to magnetic field lines. OR  
➤ Magnetic flux is maximum when area or plane is held perpendicular to magnetic field lines.



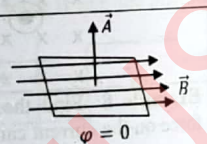
Example:

- Flux passing through  $A_1$  is four.  
➤ Flux passing through  $A_2$  is three.



## Minimum Flux:

- Flux is minimum when vector area is perpendicular to magnetic field lines. OR  
➤ Flux is minimum when area is held parallel to magnetic field lines.



## Short Cut Method

When plane or surface makes an angle ' $\theta$ ' with magnetic field lines then use the relation.  
 $\Phi = BA \sin \theta$

$\theta$	$0^\circ$	$30^\circ$	$45^\circ$	$60^\circ$	$90^\circ$
$\cos \theta$	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
$\sin \theta$	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1

## Magnetic Flux Density:

Magnetic flux per unit area when area is held perpendicular to magnetic field lines is called magnetic flux density.

$$B = \frac{\Phi}{A_1} \Rightarrow \text{SI unit is Tesla } (T = Wbm^{-2})$$

## AMPERE'S LAW

- Ampere's law is stated as

"Sum of all the quantities  $(\vec{B} \cdot \Delta \vec{L})$  for all path elements into which complete loop has been divided is equal to  $\mu_0$  times the total current enclosed by loop"

$$\sum_{i=1}^n (\vec{B} \cdot \Delta \vec{L})_i = \mu_0 I$$

Where  $\mu_0$  is permeability of free space and  
 $\mu_0 = 4\pi \times 10^{-7} Wbm^{-1}A^{-1}$

- Ampere's law is used to determine magnetic flux density.

## FIELD DUE TO A CURRENT CARRYING SOLENOID

## Solenoid:

"Solenoid is a long, tightly wound cylindrical coil which behaves like a bar, magnetic when current passes through it."

Magnetic field outside the solenoid is non-uniform and weak (can be neglected).

- Magnetic field produced at the ends of solenoid is non-uniform and  
 $B_{end} = \frac{\mu_0 n I}{2}$  ( $B_{end} = \frac{B_{center}}{2}$ )  
➤ Magnetic field produced inside the solenoid is strong and nearly uniform.

$$B = \mu_0 n I \quad \text{OR} \quad B = \frac{\mu_0 N I}{L}$$

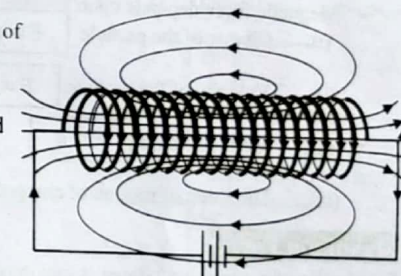
Where  $n$  is number of turns per unit length.

Magnetic field inside the solenoid depends upon.

- Number of turns of solenoid ( $B \propto N$ )
- Current passing through solenoid ( $B \propto I$ )
- Length of solenoid ( $B \propto \frac{1}{L}$ )
- Nature of core material (by increasing iron core inside the solenoid magnetic field increases)

## Three important cases:

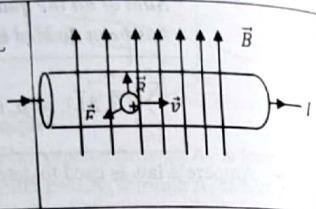
- If solenoid is stretched then its length increases but no. of turns remains same so magnetic field decreases.
- If solenoid is compressed then its length decreases but no. of turns remains same so its magnetic field increases
- If solenoid is cut into two parts and same current passes through each part then magnetic field will remain same because both no. of turns and length become half.



## FORCE ON MOVING CHARGE IN A MAGNETIC FIELD

- Force acting on a current carrying conductor in magnetic field is actually force acting on moving charges.

No. of charge carriers per unit volume =  $n$   
 No. of charge carriers in volume  $AL$  of the conductor =  $nAL$   
 Charge on each particle =  $q$   
 Total charge in the conductor of volume  $AL = nqAL$   
 Time taken by charges to pass through conductor =  $\frac{L}{v}$   
 Current passing through the conductor =  $\frac{nqAL}{\frac{L}{v}} = nqAv$



When charges are moving in the magnetic field they experience the magnetic force and the resultant of magnetic forces acting on moving charges is the magnetic force acting on current carrying conductor

- If a charge  $q$  is moving with velocity  $v$  in a magnetic field  $B$  is given as

$$F = qvB\sin\theta \quad \theta \text{ is angle between } \vec{v} \text{ and } \vec{B}$$

- Magnetic force depends upon

(i). Charge of the particle  $F \propto q$

(ii). Velocity of the particle  $F \propto v$

(iii). Magnetic field  $F \propto B$

(iv). Direction of motion of charged particle.

$$F \propto \sin\theta$$

**NOTE:** Magnetic force on moving charges is independent of length area or dimensions of the conductor.

### Maximum Force:

Force acting on a moving charge is maximum when charge is moving perpendicular to magnetic field lines.

$$F_{\max} = qvB\sin 90^\circ = qvB$$

### Minimum Force:

Force acting on a particle is zero or minimum when

- Charge is zero (neutral particle)  $\Rightarrow F = (0)vB\sin\theta = 0$
- Charged particle is at rest ( $v = 0$ ),  $\Rightarrow F = q(0)B\sin\theta = 0$
- Magnetic field is zero ( $B = 0$ ),  $\Rightarrow F = qv(0)\sin\theta = 0$
- Charge is moving either parallel or anti-parallel to magnetic field lines.  
 $F = qvB\sin\theta = qvB\sin 180^\circ = 0$

### Vector Form:

Magnetic force on moving charge in vector form is given as

$$\vec{F} = q(\vec{v} \times \vec{B})$$

- Magnetic force is always perpendicular to velocity of charge and magnetic field.

- Work done by magnetic force is always zero  
 ( $\because F_m$  is perpendicular to velocity and displacement).
- Magnetic force is only deflecting force and it cannot accelerate or decelerate the charge.
- When charge is moving in uniform magnetic field its speed, K.E, angular velocity, time period, frequency and angular momentum remain constant.
- Angular acceleration and torque by magnetic force is zero.
- Only direction of velocity, momentum, acceleration and magnetic force are changing.

### Direction of Force:

Direction of force acting on a moving charge in a magnetic field is determined by

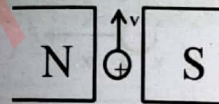
- Right hand palm rule
- Fleming left hand rule

### How to Apply Right Hand Palm Rule

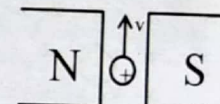
- سب سے پہلے Right hand کا تھمبہ نکالیں۔
- Fingers کی direction نیلے کی طرف set کریں۔
- ہاتھ کو Rotate کر کے thumb کی direction کرنٹ کی طرف set کریں۔
- تو جس طرف Palm کی direction ہوگی اس طرف Force عمل کرے گی۔

یاد رکھیں اگر چارج +ve کی بجائے -ve ہو تو right کی بجائے Left hand palm rule استعمال کریں۔

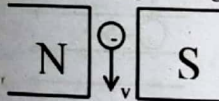
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



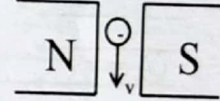
**Answer:** Direction of force is into the plane of paper



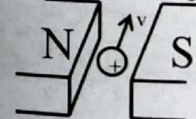
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



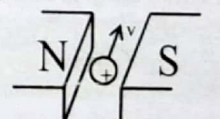
**Answer:** Direction of force is into the plane of paper



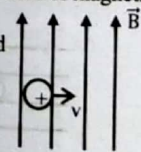
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



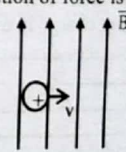
**Answer:** Direction of force is vertically downward



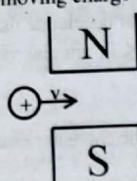
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



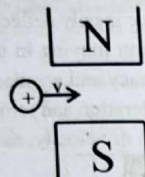
**Answer:** Direction of force is out of plane of paper



**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



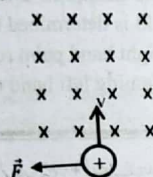
**Answer:** Direction of force is into the plane of paper



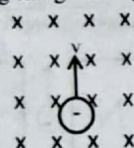
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



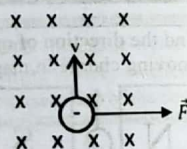
**Answer:** Direction of force is towards left



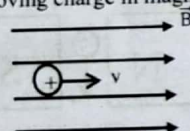
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



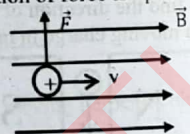
**Answer:** Direction of force is towards right



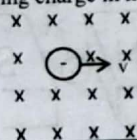
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



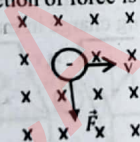
**Answer:** Direction of force is upward



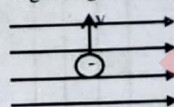
**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



**Answer:** Direction of force is downward



**Example:** find the direction of magnetic force acting on a moving charge in magnetic field



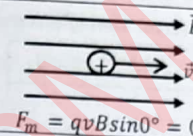
**Answer:** Direction of force is out of plane of paper



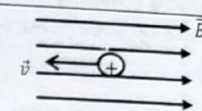
## TRAJECTORY OF A CHARGE PARTICLE IN MAGNETIC FIELD

### 1. Straight Path:

When charge is moving either parallel or anti-parallel to magnetic field lines its trajectory will be straight line.



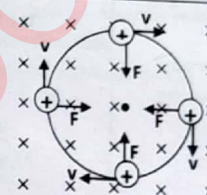
$$F_m = qvB \sin 0^\circ = 0$$



$$F_m = qvB \sin 180^\circ = 0$$

### 2. Circular Path:

When charge is moving perpendicular to magnetic field lines then its trajectory will be circular.



$$F_m = F_c$$

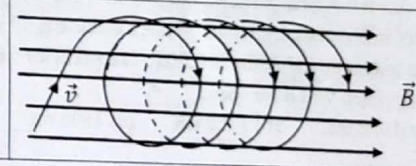
$$qvB = \frac{mv^2}{r}$$

$$\frac{q}{m} = \frac{v}{Br}$$

Radius of circular path	Angular frequency OR Angular Velocity	Time Period	Frequency
$r = \frac{mv}{qB}$	$\omega = \frac{qB}{m}$	$T = \frac{2\pi m}{qB}$	$f = \frac{qB}{2\pi m}$

### 3. Helical path :

When charge is moving neither parallel, anti-parallel or perpendicular ( $\theta$  is other than  $0^\circ$ ,  $90^\circ$  or  $180^\circ$ ) then its trajectory is helical or helix.



## COMPARISON BETWEEN ELECTRIC AND MAGNETIC FORCE

Electric Force	Magnetic Force
1. Electric force is given as $F_e = qE$ .	Magnetic force is given as $F_m = q(\vec{v} \times \vec{B})$ .
2. Electric force only depends upon charge and electric field and independent of velocity and direction of motion.	Magnetic force depends upon charge, velocity, magnetic field and direction of motion.
3. Electric force is always along the direction of electric field.	Magnetic force is always perpendicular to direction of magnetic field and velocity.
4. Electric force can accelerate, decelerate and deflect the charge.	Magnetic force is only deflecting force and cannot accelerate or decelerate the charge.

## LORENTZ FORCE

"If a charge  $q$  is moving with velocity  $\vec{v}$  in a region where electric field is  $\vec{E}$  and magnetic field is  $\vec{B}$  then the net force on the charge is vector sum of electric force  $q\vec{E}$  and magnetic force  $q(\vec{v} \times \vec{B})$ ."

$$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$$

It is known as Lorentz force.

## Velocity Selector:

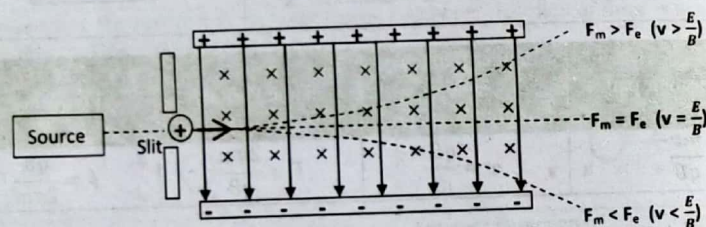
- $\vec{v}$ ,  $\vec{E}$  and  $\vec{B}$  are set mutually perpendicular.
- $\vec{E}$  and  $\vec{B}$  are applied in a such a way that they may exert force on moving charge in opposite direction.

- Only these charges passes undeviated for which

$$F_m = F_e$$

$$qvB \sin 90^\circ = qE$$

$$v = \frac{E}{B}$$



**Example:** Alpha particles ranging in speed from  $1000 \text{ ms}^{-1}$  to  $2000 \text{ ms}^{-1}$  enter into a velocity selector where electric field intensity is  $300 \text{ Vm}^{-1}$  and magnetic induction is  $0.20 \text{ T}$ . The particles which move undeviated will have speed

(a)  $1000 \text{ ms}^{-1}$  (b)  $1250 \text{ ms}^{-1}$  (c)  $1500 \text{ ms}^{-1}$  (d)  $2000 \text{ ms}^{-1}$

**Solution:**

$$v = \frac{E}{B}$$

$$v = \frac{300}{0.2} = 1500 \text{ ms}^{-1}$$

**Example:** A velocity selector has magnetic field of  $0.30 \text{ T}$  and a perpendicular electric field of  $10000 \text{ Vm}^{-1}$  is applied. Then the particles which move undeviated will have speed

(a)  $330 \text{ ms}^{-1}$  (b)  $3300 \text{ ms}^{-1}$  (c)  $33000 \text{ ms}^{-1}$  (d)  $3000 \text{ ms}^{-1}$

**Solution:**

$$v = \frac{E}{B}$$

$$v = \frac{10000}{0.3} = 33000 \text{ ms}^{-1}$$

**Example:** If a charge  $q$  is moving in a velocity selector. The charge will move in a straight path if:

- (a)  $v = \frac{E}{B}$  (b)  $E$  is perpendicular to  $B$ .  
 (c)  $F_m = F_e$  (d) All of these ✓

## CHARGE TO MASS RATIO OF AN ELECTRON

- Charge to mass ratio  $\left(\frac{q}{m}\right)$  of a particle only depends upon nature of particle.
- In case of neutron or any other neutral particle  $\frac{q}{m} = 0$  and  $\frac{m}{q} = \infty$ .
- $\left(\frac{q}{m}\right)_{\text{electron}} > \left(\frac{q}{m}\right)_{\text{proton}} > \left(\frac{q}{m}\right)_{\alpha\text{-particle}}$

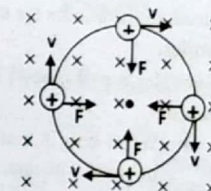
## Determination of Charge to Mass Ratio of an Electron

- To determine charge to mass ratio of electron beam of electrons is projected in uniform magnetic field in perpendicular direction.
- Magnetic field exerts the force on electrons and bends the beam in a circular path.

$$F_m = F_c$$

$$qvB = \frac{mv^2}{r}$$

$$\frac{q}{m} = \frac{v}{Br}$$



- To determine the radius of circular path beam of electrons is projected in a glass bulb filled with  $H_2$  gas at low pressure due to ionization and de-excitation path of electrons becomes visible.

- If beam of electrons is accelerated through potential difference  $V$  then

Gain in K.E:

$$K.E = qV$$

Gain in Momentum:

$$p = \sqrt{2mqV}$$

Gain in Velocity:

$$v = \sqrt{\frac{2qV}{m}}$$

- Putting value of  $V$  in eq(i)

$$\frac{q}{m} = \frac{2V}{B^2 r^2}$$

- Accurately Known value of  $e/m$  for electron is  $1.7588 \times 10^{11} \text{ Ckg}^{-1}$ .

**Example:** A charge particle is moving in a circular path in a perpendicular magnetic field. By increasing the magnetic field charge to mass ratio of the particle will:

- (a) Increase (b) decrease (c) Remain same ✓ (d) None

**Solution:**

Charge to mass ratio only depends upon nature of particles.

## UNIT 09 &gt;&gt;

## ELECTROMAGNETIC INDUCTION

**Electromagnetic Induction:**

"Changing magnetic flux through a coil induces emf this phenomenon is known as electromagnetic induction."

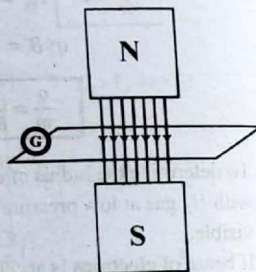
**Induced emf:**

Michael Faraday discovered that when magnetic flux linking with conductor changes an emf is produced in the conductor this emf is known as induced emf.

**Examples:**

1. Consider a coil placed between the two poles of a magnet.

- When coil is stationary no current or emf is induced because magnetic flux is not changing.
- When coil is moved along the field lines again no emf is induced because magnetic flux is not changing.
- When coil is moved across (perpendicular) to field lines, magnetic flux changes and emf is induced.

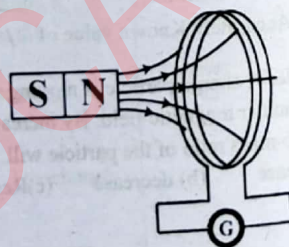


Induced emf and induced current depends upon

i. Speed of the coil ( $\epsilon \propto v$ ).	ii. Applied magnetic field intensity ( $\epsilon \propto B$ ).
iii. Number of turns of the coil ( $\epsilon \propto N$ ).	iv. Induced emf is independent of resistance of the coil. But induced current depends resistance ( $I \propto \frac{1}{R}$ ).

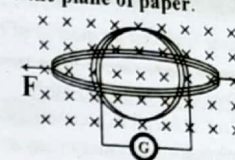
2. Consider a stationary coil and a bar magnetic is moved near the coil.

- When magnet is at rest no emf is induced because magnetic flux is not changing.
- When magnet is moved towards the coil magnetic flux increases and an emf is induced.
- When magnet is moved away magnetic flux decreases and an emf is induced.



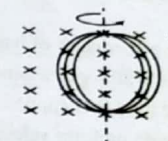
3. Consider a circular coil placed in a magnetic field directed into the plane of paper.

- Since area of the loop is constant hence magnetic flux is constant and no emf is induced in the coil.
- When coil is distorted its area decreases thus magnetic flux through the coil decrease and an emf is induced.



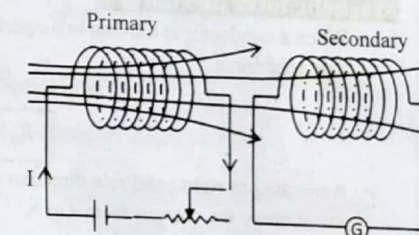
4. Consider a rotating coil placed in uniform magnetic field directed into plane of paper.

- When coil is rotated in magnetic field angle between field lines and vector area changes thus magnetic flux changes and an emf is induced.



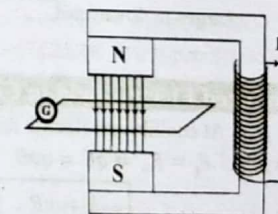
5. Consider a primary coil connected with battery and rheostat and coil connected with a galvanometer is placed near it as secondary.

- When current through primary coil is constant magnetic flux through secondary coil is also constant thus no emf is induced in secondary.
- When current through primary coil increases, magnetic flux through secondary coil increases and emf is induced in secondary coil.
- When current through primary coil decreases, flux through secondary coil also decreases thus an emf is induced in secondary coil.



6. Consider coil is placed in the magnetic field of electromagnet

- When current through electro-magnet is constant no emf is induced because magnetic flux is not changing.
- When current through electromagnet increases, magnetic flux increases thus an emf induced due to changing flux.
- When current through electromagnet decreases, magnetic flux decreases thus an emf is induced due to changing flux.



## MOTIONAL EMF

"Emf induced by motion of the conductor across the magnetic field is called motional emf."

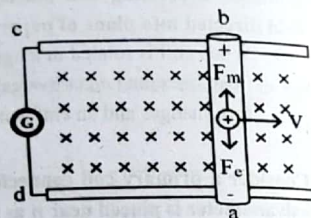
**Dynamic Induced emf:**

Emf induced in a conductor when it is moved in stationary magnetic field.

**Statically induced emf:**

Emf induced in a conductor when conductor is stationary and magnetic field is moving or charge.

Consider a conductor of length  $L$  placed on two rails connected with a galvanometer, a uniform. Magnetic field  $B$  is applied into plane of paper and rod is moving with uniform velocity  $v$ .

**Magnetic force on charges:**

- When a conductor is moving in magnetic field charges inside the conductor experience magnetic force.

$$F_m = qvB\sin\theta = qvB\sin 90^\circ \quad (\because v \perp B)$$

$$F_m = qvB$$

- According to right hand rule direction of magnetic force on +ve charges is directed upward and it move the charges from a to b.

**Electric force on charges:**

- +ve charges are concentrated at point 'a' and -ve charges are concentrated at point 'b' these +ve and -ve charges induces an electric field  $E$  which exerts an electric force on the +ve charges in downward.

$$\vec{F} = q\vec{E}$$

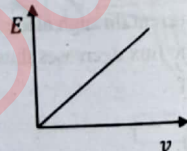
**Induced Electric field in Conductor:**

At equilibrium electric force will be come equal to magnetic force and net force on charge is zero.  $F_e = F_m \Rightarrow qE = qvB$

$$E = vB$$

- Induced electric field depends upon:

- Speed of conductor ( $E \propto v$ )
- External magnetic field ( $E \propto B$ )

**Induced Potential Difference:**

$$\Delta V = -E\Delta r = -vBL$$

$$\Delta V = -vBL$$

- Induced electric field depends upon:

- Speed of conductor ( $\Delta V \propto v$ )
- Length of conductor inside the magnetic field ( $\Delta V \propto L$ ).
- External magnetic field. ( $\Delta V \propto B$ )

**Induced emf in the conductor:**

induced emf = induced p.d

$$\varepsilon = -vBL$$

**Induced Current:**

If  $R$  is resistance of the current loop abcd then induced current is given as

$$I = \frac{vBL}{R}$$

**Induced Charge:**

Amount of induced charge in the conductor in a time interval  $\Delta t$  is given as

$$\Delta Q = I\Delta t = \frac{vBL\Delta t}{R}$$

If the angle between velocity of conductor and magnetic field lines is  $\theta$  instead of  $90^\circ$  then

**Induced electric field:**

$$E = -vB\sin\theta$$

**Induced potential difference:**

$$\Delta V = -vBL\sin\theta$$

**Induced emf:**

$$\varepsilon = -vBL\sin\theta$$

**Induced emf depends upon**

- Speed of the conductor ( $\varepsilon \propto v$ )
- Length of conductor inside the field ( $\varepsilon \propto L$ )
- External magnetic field ( $\varepsilon \propto B$ )
- Angle between velocity of conductor and magnetic field lines. ( $\varepsilon \propto \sin\theta$ )

**Maximum emf:**

Induced emf is maximum when conductor is moving perpendicular to field lines.

$$\varepsilon = vBL\sin 90^\circ$$

$$\varepsilon_{\max} = vBL$$

**Minimum emf:**

Induced emf is minimum when conductor is moving along (parallel or anti-parallel) to field lines.

$$\varepsilon = vBL\sin 0^\circ = 0$$

**Example:**

An emf of 0.5 V is induced between the ends of a metal bar moving through a magnetic field of 0.20 T. What field strength would be needed to produced an emf of 1.5 V between the ends of the bar. If all other factors remain same.

- (a) 0.3 T (b) 0.6 T (c) 0.9 T (d) 1.2 T

**Solution:**

$$(\varepsilon \propto B)$$

$$\frac{B_2}{B_1} = \frac{\varepsilon_2}{\varepsilon_1}$$

$$B_2 = \frac{1.5 \times 0.2}{0.5} = 0.6 \text{ T}$$

## FARADAY LAW

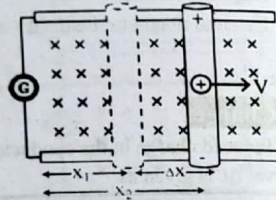
"Average induced emf in a coil of 'N' turns is equal to -ve of rate of change of change of magnetic flux through the coil."

$$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$$

## Explanation:

Consider a rod is moving on two rails connected with a galvanometer in presence of magnetic field. As area of loop increases magnetic flux changing through the flux and emf is induced.

$$\begin{aligned}\varepsilon &= -vBL \\ \varepsilon &= -\frac{\Delta x}{\Delta t} BL \\ \varepsilon &= -\frac{\Delta A}{\Delta t} B \\ \varepsilon &= -\frac{\Delta\Phi}{\Delta t}\end{aligned}$$



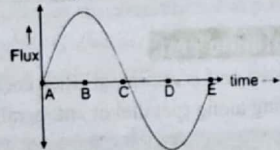
## ➤ Induced emf depends upon

- (i). Number of turns of the coil ( $\varepsilon \propto N$ ).
- (ii). Rate of change of flux through the coil ( $\varepsilon \propto \frac{\Delta\Phi}{\Delta t}$ ).

➤ Faraday law is used to determine amount of induced emf or induced current.

➤ Slope of  $\Phi - t$  graph is directly proportional to induced emf.

➤ As slope =  $\frac{\Delta\Phi}{\Delta t} \Rightarrow \text{slope} \propto (-\varepsilon)$

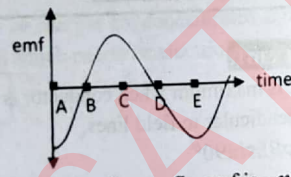


- At instants A and E slope of  $\Phi - t$  graph is +ve maximum. So emf is -ve maximum.
- At instants B and D slope of  $\Phi - t$  graph is zero emf also zero.
- At instant C slope of  $\Phi - t$  graph is -ve maximum. So emf is +ve maximum.

## Information

Faraday's designed a Homopolar generator with which he was able to produce continuous induced current.

یاد رکھیں Magnetic flux کو تین طرح سے change کیا جاسکتا ہے۔  
 (i) Magnetic field کو change کرنے سے  
 (ii) Area کو change کرنے سے  
 (iii) Magnetic field اور Area کے درمیان Angle کو change کرنے سے



## DIFFERENT FORMS OF FARADAY LAW

1. If a plane is perpendicular to field lines  $\Phi = BA \cos 0^\circ = BA$

(i) When  $B = \text{constant}$  and area is changing then  
 $\Delta\Phi = B\Delta A$  and  $\varepsilon = N \frac{B\Delta A}{\Delta t}$

(ii) When  $A = \text{constant}$  and  $B$  is changing then  
 $\Delta\Phi = (\Delta B)A$  and  $\varepsilon = N \frac{(\Delta B)A}{\Delta t}$

2. If a plane is not perpendicular to field lines  $\Phi = BA \cos \theta^\circ = BA$

(i) When  $B = \text{constant}$  and area is changing then  
 $\Delta\Phi = B\Delta A \cos \theta$

$$\text{and } \varepsilon = N \frac{B\Delta A \cos \theta}{\Delta t}$$

(ii) When  $A = \text{constant}$  and  $B$  is changing then  
 $\Delta\Phi = (\Delta B)A \cos \theta$

$$\text{and } \varepsilon = N \frac{(\Delta B)A \cos \theta}{\Delta t}$$

## Induced Current:

If  $R$  is resistance of the coil then induced current is given as  $I = \frac{\varepsilon}{R}$

$$\text{or } I = N \frac{\Delta\Phi}{R\Delta t}$$

## Induced current depends upon

- (i). No. of turns of coil ( $I \propto N$ )
- (ii). Rate of change of flux ( $I \propto \frac{\Delta\Phi}{\Delta t}$ )
- (iii). Resistance of coil ( $I \propto \frac{1}{R}$ )

## Induced Charge:

Induced charge in a time interval  $\Delta t$  is given as

$$\Delta Q = I\Delta t = \frac{N\Delta\Phi}{R\Delta t} \times \Delta t \quad \text{OR} \quad \Delta Q = \frac{N\Delta\Phi}{\Delta R}$$

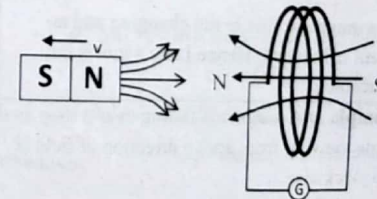
## LENZ'S LAW

Lenz pointed out that -ve sign in Faraday law ( $\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$ ) indicates that

"The direction of induced current is always so as to oppose that change which causes the current".

➤ Whenever magnetic flux changes a current is induced which produces a magnetic field that opposes the change in flux.

- When flux increases it tends to decrease flux.
- When flux decreases it tends to increase the flux



**NOTE:**

Lenz's law is in according to law of conservation of energy.

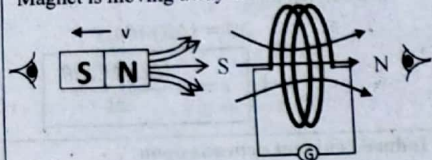
**NOTE:** Lenz's law is used to determine the polarity of induced emf or direction of induced current.

### HOW TO DETERMINE DIRECTION OF INDUCED CURRENT

#### Case-I When distance between coil and magnetic is increasing or decreasing.

**Example 1:**

Magnet is moving away from coil.

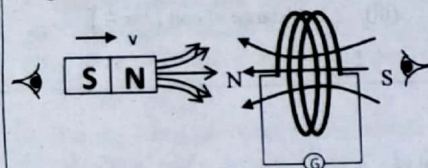


مندرجہ ذیل steps کو ترتیب سے follow کریں:

- اگر دور جا رہے ہوں تو ان میں attraction پیدا ہوگی۔
- Magnet والی side پر opposite پول اور دوسری N والی side پر same پول پیدا ہوگا۔
- N والی side سے دیکھیں تو کرنٹ anticlockwise اور 'S' والی side سے current کا اک دائرہ نظر آئے گا۔

**Example 2:**

Magnet is moving towards the coil

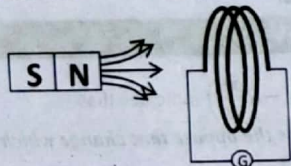


مندرجہ ذیل steps کو ترتیب سے follow کریں:

- اگر قریب آ رہے ہوں تو ان میں repulsion پیدا ہوگی۔
- Magnet والی side پر same پول پیدا ہوگا۔
- دوسری N والی side پر opposite پول پیدا ہوگا۔
- N والی side سے دیکھیں کو current, anticlockwise اور 'S' والی side سے current کا اک دائرہ نظر آئے گا۔

**Example 3:**

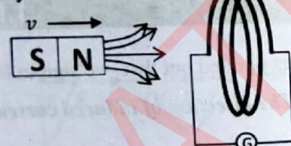
Magnet and coil are stationary



Since magnetic flux is not changing and no current is induced. Hence Lenz's law is not applicable

**Example 4:**

they are moving in same direction with same velocity



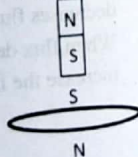
Since magnetic flux is not changing and no current is induced. Hence Lenz's law is not applicable

**Example 3:** A magnet is falling over a loop as shown in the figure below viewing from above direction of field is

- clockwise
- anti-clockwise
- either clockwise or anti clockwise
- no current is induced

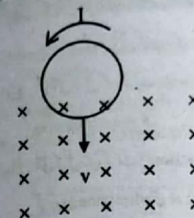


Answer clockwise



#### Case-II When magnetic flux is increasing or decreasing:

##### Example 1: When magnetic flux is increasing:

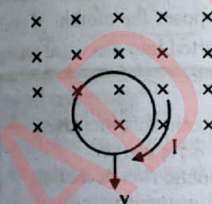


مندرجہ ذیل steps کو ترتیب سے follow کریں:

- جب کوئل enter ہوگی تو اس میں سے flux بڑھے گا۔
- Induced کرنٹ flux کو کم کرنے کے لیے opposite سینکٹیف فیلت پیدا کرے گا۔
- کیونکہ پہلے فیلت into the paper ہے تو نیا فیلت out of paper پیدا ہوگا۔
- اگرچہ out of paper کر کے دائیں ہاتھ کی انگلیاں گھماؤ کی direction مل جائے گی۔

**Example 2:**

When magnetic flux is decreasing:

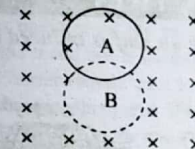


مندرجہ ذیل steps کو ترتیب سے follow کریں:

- جب کوئل exit ہوگی تو اس میں سے flux کم گا۔
- Induced کرنٹ flux کو زیادہ کرنے کے لیے same direction میں سینکٹیف فیلت پیدا کرے گا۔
- کیونکہ پہلے فیلت into the paper ہے تو نیا فیلت out of paper پیدا ہوگا۔
- اگرچہ out of paper کر کے دائیں ہاتھ کی انگلیاں گھماؤ کی direction مل جائے گی۔

**Example 3:**

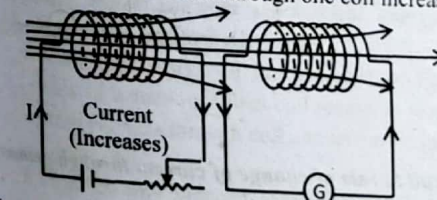
When coil moves from A to B magnetic flux is constant:



Since magnetic flux is not changing hence no current is induced in the coil.

#### Case-III When current through one coil is increasing or decreasing.

##### Example 1: When current through one coil increases



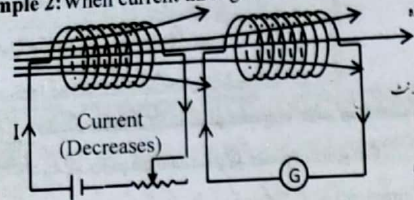
مندرجہ ذیل steps کو ترتیب سے follow کریں:

- جب پہلی coil کا کرنٹ بڑھے گا تو دوسری coil کا کرنٹ اس کو کم کرنے کی کوشش کرے گا۔
- اگر پہلی کوئل میں کرنٹ clockwise ہے تو دوسری کوئل میں کرنٹ anti-clockwise پیدا ہوگا۔
- پہلی کوئل میں کرنٹ کی direction دیکھیں اور دوسری کوئل میں کرنٹ کی direction اس کے opposite ہوگی۔

Clockwise Current

Induced Current is anti-clockwise

Example 2: When current through one coil decreases.



Clockwise Current

Induced Current is clockwise

### LENZ'S LAW AND CONSERVATION OF ENERGY

Lenz's law is consistent with law of conservation of energy. whenever current is induced by motion of coil or magnet they experience a magnetic force which opposes the motion of coil or magnet. Thus mechanical energy spent to overcome opposition is converted into electrical energy.

#### NOTE

When current is induced in a conductor due to its motion it experiences magnetic force opposite to velocity.

#### NOTE

- Whenever magnetic flux increases, magnetic force is repulsive.
- Whenever magnetic flux decreases, magnetic force is attractive.

### MUTUAL INDUCTION

"When current passing through primary coil changes an emf is induced in secondary coil this phenomenon is known as mutual induction".

- Flux  $\Phi$  passing through each turn of secondary coil is directly proportional to current through the primary coil.

$$N_s \Phi_s \propto I_p$$

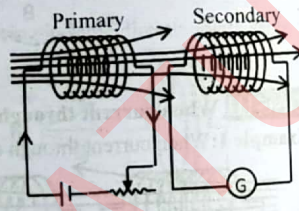
$$N_s \Phi_s = M I_p$$

or

$$N_s \Delta \Phi = M \Delta I_p$$

- Induced emf in secondary coil is

$$\varepsilon_s = -M \frac{\Delta I_p}{\Delta t}$$



#### Mutual inductance:

"Ratio of average induced emf in secondary coil to rate of change of current through primary coil is called mutual inductance."

Its SI unit is Henry ( $H = VsA^{-1}$ )

- Mutual inductance depends upon:
  - Number of turns of coils.
  - Area of the coils.
  - Closeness and orientation of coils.
  - Nature of core material.

### SELF INDUCTION

"When current passing through the coil changes an 'emf is induced in the coil itself'".

Flux passing through each turn of the coil is directly proportional to current passing through coil.

$$N\Phi \propto I$$

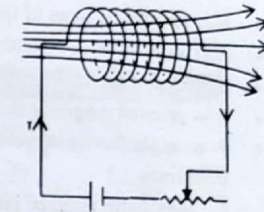
$$\varepsilon = -L \frac{\Delta I}{\Delta t}$$

$$\Rightarrow \varepsilon \propto L \text{ and } \varepsilon \propto \frac{\Delta I}{\Delta t}$$

$$N\Phi = LI$$

and

$$N\Delta\Phi = L\Delta I$$



L is proportionality constant and it is known as self inductance.

#### Self Inductance

Ratio of average induced emf in the coil to rate of change of current through the coil.

- Its SI unit is henry ( $H = VsA^{-1}$ )

Self inductance depends upon

- Shape and number of turns of coil
- Nature of core material
- Area and length of the coil

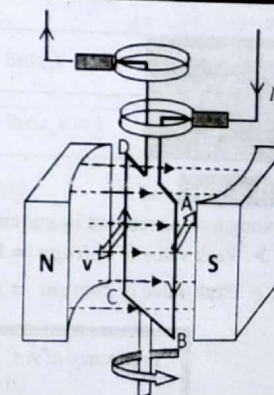
#### Information

Induction heater operates on the principle of electromagnetic induction. The water placed on it in the metal pot is boiling whereas that in the glass pot is not. Even the glass top of the heater remain cool to touch. The coil just beneath the top carries ac that produces changing magnetic flux. Flux linking with pots induce emf in them. Current is generated only in the metal pot that heats up the water.

### A.C GENERATOR

"A device which converts mechanical energy into electrical energy is called generator."

- Generator works on the principle of Faraday law of induction. When coil rotates in magnetic flux changes through coil and an emf is induced in the coil.
- Emf is only induced along the conductor AB and CD because force acting on the charges is along the wire.
- Emf induced along the conductor BC and DA is zero because force on charges is not along the wire



**Induced Emf:**

Emf induced in generator is dynamically induced emf and it is given as

$$\varepsilon = N\omega AB \sin\theta$$

or

$$\varepsilon = \varepsilon_0 \sin\theta$$

- $N$  is number of turns of the coil.
- $\omega$  is angular velocity with which coil is rotated.
- $A$  is area of the coil.
- $B$  is external magnetic field in which coil is rotated.
- $\theta$  is angle between velocity of coil and magnetic field lines.

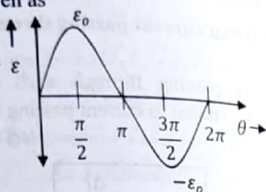
➤ Maximum induced emf is given as

$$\varepsilon = N\omega AB$$

or

$$\varepsilon_0 = N(2\pi f)AB$$

$$\varepsilon_0 = N \left( \frac{2\pi}{T} \right) AB$$

**Induced Current:**

Induced current is given as  $I = \frac{\varepsilon}{R} = \frac{\varepsilon_0 \sin\theta}{R}$

or

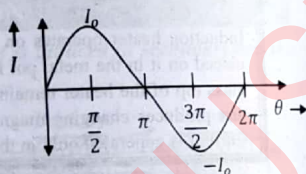
$$I = I_0 \sin\theta$$

Current and voltage produced by A.C generator are continuously changing with time.

$$\text{Where } I_0 = \frac{\varepsilon_0}{R} = \frac{N\omega AB}{R}$$

In one revolution of generator one cycle of A.C

- Current reverses its direction once.
- Current reaches to maximum value twice.
- Current reaches to zero value twice.
- Emf or voltage reverses its polarity once.

**Instantaneous value:**

Value of alternating current or voltage at any particular instant of time is called instantaneous value.

Instantaneous voltage	$V = V_0 \sin\theta$	$V = V_0 \sin\omega t$	$V = V_0 \sin 2\pi ft$	$V = V_0 \sin \frac{2\pi}{T} t$
Instantaneous current	$I = I_0 \sin\theta$	$I = I_0 \sin\omega t$	$I = I_0 \sin 2\pi ft$	$I = I_0 \sin \frac{2\pi}{T} t$

**Peak value:**

Maximum value reached by current or voltage in a cycle is called peak value.

➤ Peak value of voltage  $= V_0 = N\omega AB$

➤ Peak value of current  $= I_0 = \frac{V_0}{R} = \frac{N\omega AB}{R}$

Frequency of A.C used in Pakistan is 50 Hz.

**Peak to peak value:**

Sum of +ve peak value and -ve peak value is called peak to peak value.

$$> V_{p-p} = V_0 + V_0 = 2V_0$$

$$> I_{p-p} = I_0 + I_0 = 2I_0$$

**Root mean square value:**

Effective value of alternating current or voltage obtained by taking square root of mean square value is called root mean square value.

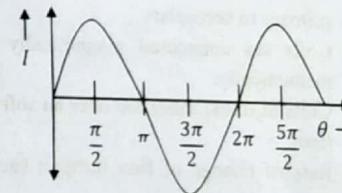
For voltage	For current
$V_{rms} = \frac{V_0}{\sqrt{2}} = 0.7V_0$	$I_{rms} = \frac{I_0}{\sqrt{2}} = 0.7I_0$
OR $V_0 = \sqrt{2} V_{rms} = 1.4V_{rms}$	OR $I_0 = \sqrt{2} I_{rms} = 1.4I_{rms}$

**Phase:**

Angle  $\theta$  which specifies the instantaneous value of alternating current or voltage is called phase.

➤ When  $\theta = n\pi$  current is zero

➤ When  $\theta = \frac{\text{odd}\pi}{2}$  current is maximum.



**Example:** If the expression for alternating voltage is  $V = 50 \sin 100\pi t$ . Then by comparing with the standard equation  $V = V_0 \sin \omega t$  we can find the following as

$$V = 50 \sin 100\pi t$$

$\downarrow$   $\downarrow$   
 $V_0$   $\omega$

Peak value	Peak to peak value	rms value	Angular frequency	Frequency	Time period
$V_0 = 50V$	$V_{p-p} = 2V_0 = 100V$	$V_{rms} = \frac{V_0}{\sqrt{2}} = 0.7 \times 50 = 35V$	$\omega = 100\pi$	$f = \frac{\omega}{2\pi} = 50Hz$	$T = \frac{1}{50}$

**Example:**

If alternating voltage is given as  $V = 350 \sin 100\pi t$  then rms value of voltage will be

(a) 175V

(c) 350V

(b) 700V

(d) 240V

**Solution :**

$$V = 350 \sin 100\pi t$$

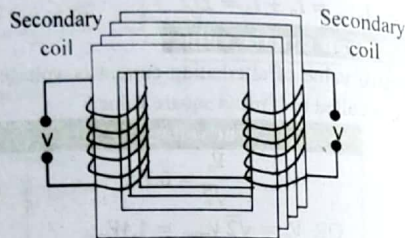
$$V_0 = 350V$$

$$V_{rms} = \frac{V_0}{\sqrt{2}} = 0.7 \times 350 = 240V$$

## TRANSFORMER

"Transformer is a device which is used to change a given alternating emf into larger or smaller alternating emf".

- Transformer works on principle of mutual induction. Alternating current passing through primary creates a continuously changing magnetic flux through secondary that induces an emf in secondary.
- Transformer only works on A.C and never on D.C.
- Coils of transformer are not connected electrically so there is no transfer of charge from primary to secondary.
- Coils are connected magnetically and power is transferred from primary to secondary magnetically.
- Coils of transformer are over an soft iron laminated core which concentrates the magnetic field lines.
- Rate of change of flux through each cell must be same.



Then

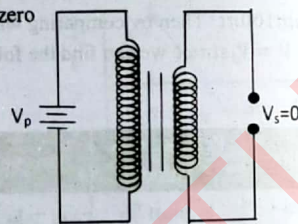
$$V_p = N_p \frac{\Delta \Phi}{\Delta t} \quad \text{and} \quad V_s = N_s \frac{\Delta \Phi}{\Delta t}$$

OR  $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

Where  $\frac{N_s}{N_p}$  is known as transformation ratio.

**Note:**

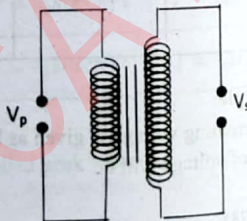
When a D.C source (battery) is connected with primary then output voltage and power are always zero



## Step-up transformer:

A transformer which is used to change a given alternating emf into larger alternating emf.

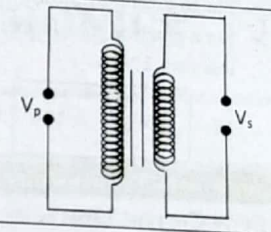
- Increases the voltage level ( $V_s > V_p$ )
- Decreases the current level ( $I_s < I_p$ )
- Power level remains same ( $P_{in} = P_{out}$ )
- Time period or frequency of A.C remains same.



## Step-down transformer:

A transformer which is used to change a given alternating emf into smaller alternating emf.

- $N_s < N_p$
- Decreases the voltage level ( $V_s < V_p$ )
- Decreases the current level ( $I_s > I_p$ )
- Power level remains same ( $P_{in} = P_{out}$ )
- Time period or frequency of A.C remains same.



## Ideal transformer:

A transformer in which output power is equal to its input power ( $P_{loss} = 0$ ) is known as ideal transformer.

$$P_{in} = P_{out}$$

$$V_p I_p = V_s I_s$$

OR

$$\frac{V_s}{V_p} = \frac{I_p}{I_s}$$

OR

$$\frac{I_s}{I_p} = \frac{N_p}{N_s}$$

If a primary coil of a transformer is connected to A.C mains then  $V_p = \text{Constant}$

and

$$I_p \propto P_{out}$$

## (i). Use of Transformer in Power Transmission:

- If R is resistance of transmission line then power loss in transmission line due to heating effect is given by  $I^2 R$ .
- The power loss can be reduced by decreasing current level.
- Step-up transformer is used at power generating stations.
- Power is transmitted at high voltage and at low current and thus power loss in transmission line is considerably reduced.
- At other end a step-down transformer is used to decrease the voltage level and increases the current level.

## Efficiency of Transformer:

The ratio of output power to input power is known as efficiency of transformer

$$\eta = \frac{P_{out}}{P_{in}} \times 100$$

- For an ideal transformer  $\eta = 100\%$  ( $P_{in} = P_{out}$ )
- For a practical transformer due to power losses in transformer  $P_{out} < P_{in}$  and efficiency is less than 100%.

$$\text{OR } \eta = \frac{V_s I_s}{V_p I_p} \times 100 \quad \text{OR } \eta = \frac{P_{out}}{P_{out} + P_{loss}} \quad \text{OR } \eta = \frac{P_{in} + P_{loss}}{P_{in}} \times 100$$

**Power loss in Transformer:****1. Eddy Current Loss:**

"When a metal conductor is placed in a changing magnetic field a current is induced in metal conductor this current is known as eddy current".

- Some power is lost in form of heat due to eddy current produced in the core of transformer.
- To reduce the eddy current loss core should be assembled with laminated plates of iron.

**2. Hysteresis loss:**

"Energy expended to magnetise and demagnetize the core material in each cycle of A.C is called hysteresis loss".

- Some power is lost to magnetise and demagnetize the core again and again.
- To reduce the hysteresis loss soft iron core should be used having narrow hysteresis loop.

**3. Cu loss:**

- When current passes through primary and secondary of transformer some power is lost due to the resistance of coils ( $P = I^2 R$ ).
- To reduce the Cu loss thick Cu wire is used for winding.

**4. Magnetic Flux Leakage:**

- Flux passing through primary is not completely linked with secondary.
- To reduce this loss secondary coil is kept inside the primary coil by using "E shaped" plates of iron core.

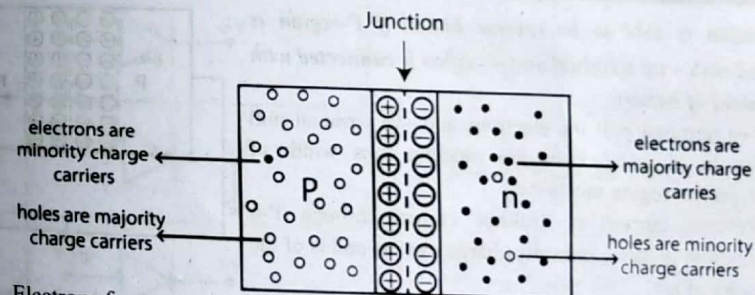
**UNIT 10 >>****ELECTRONICS**

A review of P-type and n-type semiconductors

P-type semiconductor	n-type semiconductor
<ul style="list-style-type: none"> <li>➤ Trivalent (III-group) impurity atoms are added in pure semi-conductor.</li> <li>➤ Trivalent atoms are known as acceptor atoms e.g. B, Al, Ga, etc.</li> <li>➤ Majority charge carriers are holes.</li> <li>➤ Minority charge carriers are electron.</li> <li>➤ Holes move from high potential to low potential.</li> <li>➤ Mobility of holes is low</li> </ul>	<ul style="list-style-type: none"> <li>➤ Penta-valent (V-group) impurity atoms are added in pure semi-conductor.</li> <li>➤ Penta-valent atoms are known as donor atoms e.g. P, Bi, Sb, Sn etc.</li> <li>➤ Majority charge carriers are electrons.</li> <li>➤ Minority charge carriers are holes.</li> <li>➤ Electrons move from low potential to high potential.</li> <li>➤ Mobility of electrons is high.</li> </ul>

**ELECTRONICS**

"When a crystal of Si or Ge is grown in such a way that one half is doped with trivalent impurity and other half is doped with pentavalent impurity p-n junction is formed."



- Electrons from n-region diffuse to p-region thus a layer of +ve immobile ions is formed in p- and n-region and around the junction.

**Depletion Region:**

"Region produced across the junction containing immobile ions and no charge carriers is called depletion region."

- Depletion region contain immobile (stationary) ions which do not act as charge carriers.

**Potential barriers OR Knee Voltage:**

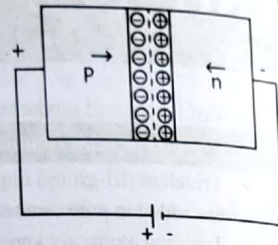
"Potential difference produced across the junction which stops the diffusion of electrons is called potential barrier or knee voltage."

- Potential barriers is 0.3V for germanium and 0.7V for silicon.

**Forward biases P-n junction**

"p-n junction is said to be forward biased if P-region is connected with +ve and n-region with -ve terminal of battery."

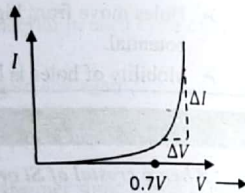
- +ve terminal repel the holes towards the junction and -ve terminal repel the electrons towards the junction thus width of depletion region decreases.
- When applied voltage is greater than potential barrier electrons and holes crosses the junction and a current starts flowing through P-n junction.
- Forward current is due to majority charge carriers and is order of mA.
- Maximum current limit for a junction is decided by power.

**Forward Resistance:**

Resistance of P-n junction when it is forward biased is called forward resistance.

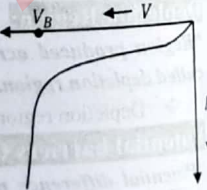
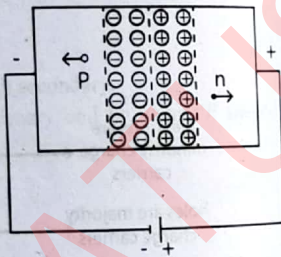
$$r_f = \frac{\Delta V}{\Delta I}$$

(its value is very small in few ohms)

**Reverse biased P-n junction:**

P-n junction is said to be reverse biased if P-region is connected with -ve terminal and n-region is connected with +ve terminal of battery.

- +ve terminal pull the electrons and -ve terminal pull the holes away from the junction thus width of depletion region increases.
- Reverse current or leakage current through P-n junction is due to minority charge carriers and is of the order of  $\mu A$ .
- If reverse voltage is increased covalent bonds break and large number of electrons are released. This causes a sudden increase in current. This is called **Zener effect**.
- If reverse bias voltage is increased further, minority charge carriers attain high velocity and knock down the bound electrons from covalent bonds by collisions and current increases rapidly this is called **Avalanche effect** or avalanche break down.
- reverse resistance of P-n junction is very large and is of the order of mega-ohms.



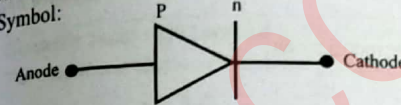
**Note:** Net current through the junction is due to electrons and holes which is given by

$$I = I_e + I_h$$

**DIODE**

A P-n junction is known as semi-conductor diode.

Symbol:



Arrow کی direction کو ظاہر کر رہی ہے مطلب Arrow والی

direction سے کرنٹ گزر سکتا ہے اور دوسری direction

کرنٹ نہیں گزر سکتا۔

Forward biased diode Examples		Reverse biased diode Examples	
Forward biased ہونے کیلئے anode کا potential high اور cathode کا potential low ہونا چاہیے۔		Reverse biased ہونے کیلئے anode کا potential low اور cathode کا potential high ہونا چاہیے۔	
1.			
2.			
3.			
4.			

## RECTIFICATION

"Process of conversion of alternating current into direct current is called rectification."

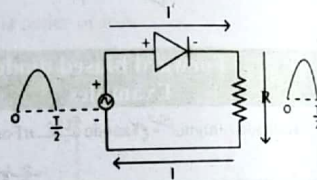
- Device which is used to convert A.C into D.C is called rectifier.
- Diode can be used as rectifier.
- There are two types of rectification.
  - Half wave rectification
  - Full wave rectification

**Half wave rectification:**

- "A type of rectification in which only one half of A.C is converted into D.C is called half wave rectification."
- Minimum one diode is required for half wave rectification.

**During +ve half cycle:**

- Diode is forward biased.
- Resistance of diode will become very small.
- Output pulse is +ve.
- Voltage drop across the diode is approximately zero.
- Voltage drop across the load resistance R is equal to source voltage.



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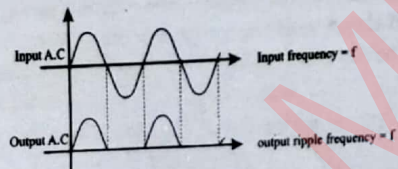
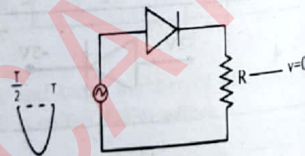
- ve half دینے سے A.C source کا اوپر والے Terminal کو +ve لیں گے۔
- اگر R میں کرنٹ downward ہو تو output pulse +ve بتائیں گے۔

**Note**

**Peak Inverse Voltage: (PIV)**  
PIV is maximum reverse voltage that a diode rectifier can block in reverse biased state.

**During -ve half cycle:**

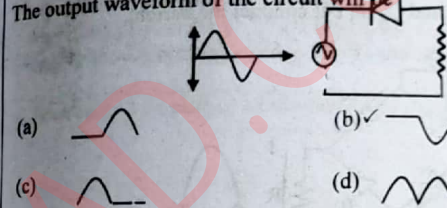
- Diode is reverse biased.
- Resistance of diode will become very large.
- Output voltage is zero.
- Voltage drop across load resistance R is zero.
- Voltage drop across the diode is maximum equal to source voltage.



- If 'f' is frequency of input signal then output ripples also have frequency 'f'
- If 'T' is time period of input signal then output ripples also have time period 'T'

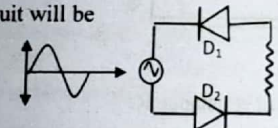
Average output in a cycle	Output rms value	Form factor $\left(\frac{V_{rms}}{V_{dc}}\right)$	Ripple Factor $\left(\sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}\right)$	Efficiency
$V_{dc} = \frac{V_o}{\pi}$	$V_{rms} = \frac{V_o}{2}$	$\frac{\pi}{2} = 1.57$	1.21	40.6%

**Example:** Input signal applied to the circuit is shown in the figure. The output waveform of the circuit will be

**Solution:**

During positive half diode will become reverse biased.  
During negative diode will become forward biased and output will be negative pulse

**Example:** Input signal applied to the circuit is shown in the figure. The output of the circuit will be

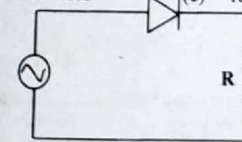
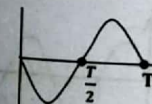


- (a) Half wave D.C (b) Full wave D.C  
(c) A.C (d) Zero ✓

**Solution:**

During positive half diode D<sub>1</sub> will become reverse biased.  
During negative diode D<sub>2</sub> will become reverse biased and output will be zero in both halves

- The width of depletion region during forward biased mode of a PN-junction diode:
  - Decreases
  - Increases
  - Remains same
  - None of these
- If is given to following circuit:



The output voltage during  $0 \rightarrow \frac{T}{2}$  will be:

- (a) Positive half (b) Negative half  
(c) Zero (d) A.C
- A full wave rectifier is being used to rectify an A.C voltage of 110 V, 60 Hz. The number of pulses of rectified current obtained in five seconds is:
    - 300
    - 60
    - 600
    - 120
  - In a full-wave center tap transformer rectifier, how many diodes conduct at a time?
    - 1
    - 2
    - 3
    - 4

**Full Wave Rectification:**

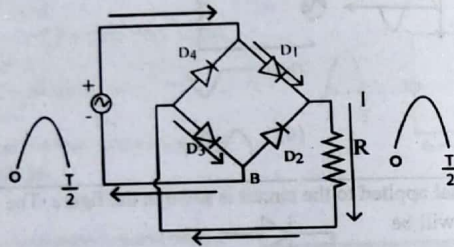
- > A type of rectification in which both halves of A.C are converted into D.C is called full wave rectification.
- > There are two types of full wave rectification.
  - Full wave bridge rectifier.
  - Center tap transformer full wave rectifier

**Bridge Rectifier:**

- > Minimum four diodes are used for bridge rectifier.

**During +ve half cycle:**

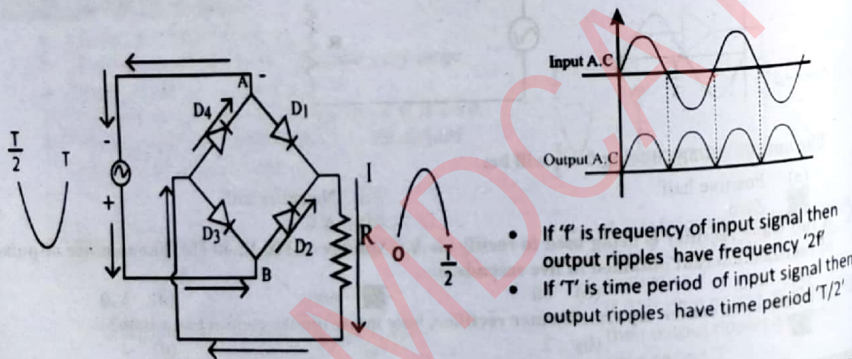
- > Point A becomes +ve which makes  $D_1$  forward biased and  $D_4$  reverse biased.
- > Point B becomes -ve which makes  $D_3$  forward biased and  $D_2$  reverse biased.
- > Diodes  $D_1$  and  $D_3$  conduct but diodes  $D_2$  and  $D_4$  do not conduct the current.



- > Maximum voltage is dropped across the load resistance R.

**During -ve half cycle:**

- > Point A becomes -ve which makes  $D_4$  forward biased and  $D_1$  reverse biased.
- > Point B becomes +ve which makes  $D_2$  forward biased and  $D_3$  reverse biased.
- > Diodes  $D_2$  and  $D_4$  conduct but diodes  $D_1$  and  $D_3$  do not conduct the current.
- > Output is +ve pulse.

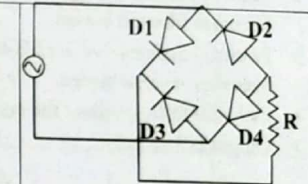
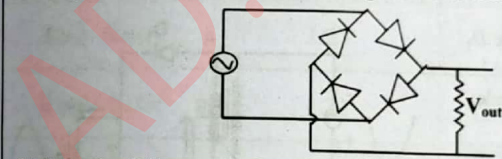


Average output in a cycle	Output rms value	Form factor $\left(\frac{V_{rms}}{V_{dc}}\right)$	Ripple Factor $\left(\sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}\right)$	Efficiency
$V_{dc} = \frac{2V_o}{\pi}$	$V_{rms} = \frac{V_o}{\sqrt{2}}$	1.11	0.48	81.2%

**Example:**

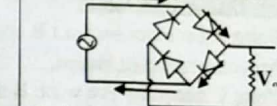
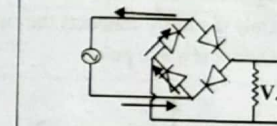
In the following figure what happens for the positive half cycle of the input?

- $D_1$  and  $D_4$  conduct
- $D_1$  and  $D_2$  conduct
- $D_3$  and  $D_2$  conduct
- $D_4$  and  $D_3$  conduct

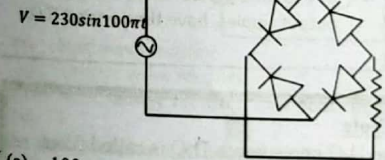
**Example: The output of the following circuit will be:**

- Pulsating full wave D.C
- Pulsating half wave D.C
- Sinusoidal A.C
- zero ✓

In both halves current through resistance is zero

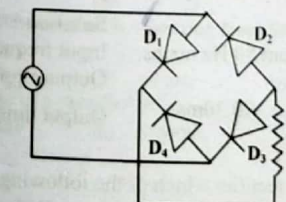
**Solution: during +ve half****During -ve half**

- The time period of the ripple at the output of the following circuit is:



- 100 ms
- 20 ms
- 50 ms
- 10 ms

- In the following figure what happens for the negative half cycle of the input?



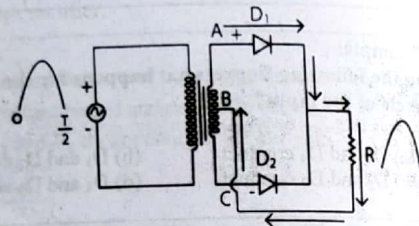
- $D_1$  and  $D_3$  conduct
- $D_1$  and  $D_2$  conduct
- $D_4$  and  $D_2$  conduct
- $D_4$  and  $D_3$  conduct

## CENTER TAP TRANSFORMER RECTIFIER

A center-tap transformer rectifier uses transformer with center-tapped secondary winding which splits the secondary voltage into two parts and two diodes which conduct alternatively.

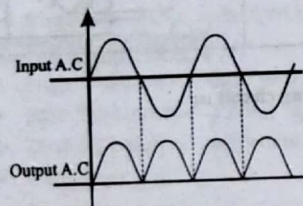
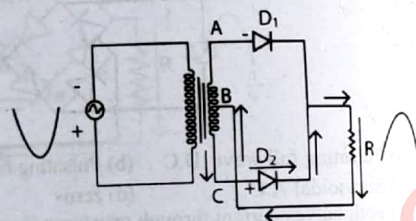
### During +ve half cycle:

- Point A becomes +ve w.r.t B and diode  $D_1$  becomes forward biased.
- Point C becomes -ve w.r.t B and diode  $D_2$  becomes reverse biased.
- Only diode  $D_1$  conduct the current.
- Output is +ve pulse.



### During -ve half cycle:

- Point A becomes -ve w.r.t B and diode  $D_1$  becomes reversed biased.
- Point C becomes +ve w.r.t B and diode  $D_2$  becomes forward biased.
- Only diode  $D_2$  conducts the currents.
- Output is a +ve pulse.



- If ' $f$ ' is frequency of input signal then output ripples have frequency ' $2f$ '
- If ' $T$ ' is time period of input signal then output ripples have time period ' $T/2$ '

### Note

- A circuit which converts pulsating D.C into smooth D.C is called filter.
- Capacitor, inductor or their combination can be used as filter.

### Example:

If a full wave rectifier circuit is operating from 50 Hz mains, then the time period of output ripples will be:

- (a) 20 ms    (b) 40 ms    (c) 10ms    (d) 30ms

### Solution:

Input frequency = 50Hz

Output ripple frequency = 100 Hz

Output time period =  $\frac{1}{100} = 10\text{ms}$

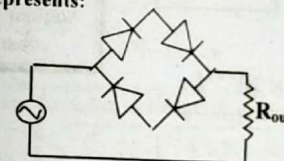
### Example:

In case of center tap transformer full wave rectifier which of the following statement is true

- (a) minimum two diodes are required    (b) only one diode conducts at a time  
(c) frequency of output ripple is half of input signal    (d) all of these ✓

	Half wave rectifier	Full wave bridge rectifier	Center tap transformer rectifier
Minimum of diodes required	1	4	2
Output ripple frequency	$f$	$2f$	$2f$
Output ripple time period	$T$	$\frac{T}{2}$	$\frac{T}{2}$
Average output in a cycle	$\frac{V_o}{\pi}$	$\frac{2V_o}{\pi}$	$\frac{2V_o}{\pi}$
Output rms value	$\frac{V_o}{2}$	$\frac{V_o}{\sqrt{2}}$	$\frac{V_o}{\sqrt{2}}$
Form factor	1.57	1.11	1.11
Ripple factor	1.21	0.48	0.48
Efficiency	40.6%	81.2%	81.2%

1. The following circuit represents:



- (a) Half wave rectifier    (b) Full wave rectifier  
(c) Quarter wave rectifier    Not a rectifier
2. In a full wave bridge rectifier, how many diodes conduct at a time?  
(a) 1    (b) 2    (c) 3    (d) 4
3. If the time period of A.C source applied on the input of full wave rectifier is  $T_1$  and time period of the output ripple is  $T_0$ , then the relation between these two is:  
(a)  $T_0 = 2T_1$     (b)  $T_0 = \frac{T_1}{\sqrt{2}}$     (c)  $T_0 = \sqrt{2} T_1$     (d)  $T_1 = 2T_0$
4. If a full wave rectifier circuit is operating from 50 Hz mains, then the time period of output ripples will be:  
(a) 10 ms    (b) 40 ms    (c) 50 ms    (d) 80 ms
5. The output voltage of a rectifier is:  
(a) Straight line    (b) Smooth    (c) Pulsating    (d) None of these

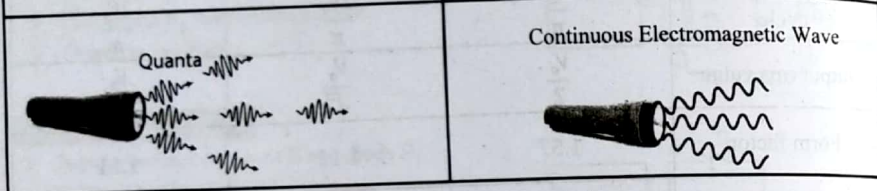
## UNIT 11 &gt;&gt;

## DAWN OF MODERN PHYSICS

## Plank's Assumption:

"Energy is emitted or absorbed by atoms in discrete packets called quanta rather than as a continuous wave."

But according to classical electromagnetic theory of radiations energy was emitted or absorbed by atoms as a continuous wave. And energy is uniformly distributed over the wave.



## Plank's Law:

Energy of each quantum is directly proportional to its frequency.

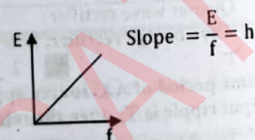
$$E \propto f \quad \text{OR} \quad E = hf$$

Where 'h' is plank's constant and

$$h = 6.626 \times 10^{-34} \text{ J.s or } h \approx 6.63 \times 10^{-34} \text{ J.s}$$

- > SI unit of Plank's constant is  $\text{J.s} = \text{kgm}^2\text{s}^{-1}$
- > Dimensions of plank's constant are  $[\text{ML}^2\text{T}^{-1}]$

The graph between energy and frequency of photons is a straight line and its slope represent the Plank's constant.



- > Atoms or molecules emit or absorb energy when they jump from one quantum state to another.  
(Emitted or absorbed energy = difference in energy between two levels).

4hf	5
3hf	4
2hf	3
1hf	2
0	1

## PHOTON THEORY

"According to Einstein photons (discrete energy packets) are integral part of all the electromagnetic radiations."

- > These photons carriers energy and momentum.
- > Photon cannot be subdivided (elementary particle).
- > Rest mass of photon is zero.
- > Charge on the photon is zero. Hence they are not affected by electric and magnetic field.
- >  $\gamma$ -radiation with energy about  $1\text{MeV}$ . Their quanta can be easily detected.
- > Radio waves with energy about  $10^{-10}\text{eV}$ . Their quanta cannot be detected and wave property of radio waves predominates.

## Energy of Photon:

Energy of photon in terms of frequency is given as	Energy of photon in terms of wavelength is given as	Energy of photon in terms of momentum is given as
$E = hf$	$E = \frac{hc}{\lambda}$	$E = pc$
$E \propto f$	$E \propto \frac{1}{\lambda}$	$E \propto p$

Short cut formula to determine energy of photon :

$$E = \frac{1240 \times 10^{-9}}{\lambda} \text{ eV}$$

## Example:

Energy of blue light photon having wavelength  $\lambda = 400\text{nm}$  is

- (a) 1.3 eV
- (b) 3.1 eV ✓
- (c) 1.2 eV
- (d) 2.1 eV

$$\begin{aligned} \text{Solution: } E &= \frac{1240 \times 10^{-9}}{400 \times 10^{-9}} \\ &= \frac{12.4}{4} \text{ eV} = 3.1 \text{ eV} \end{aligned}$$

## Example:

Which of the following radiations photon carries the most energy

- (a) ultraviolet
- (b) microwaves
- (c) visible light
- (d) x-rays ✓

## Solution:

x-rays have shortest wavelength

$$E \propto \frac{1}{\lambda}$$

**Example:**

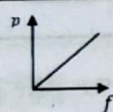
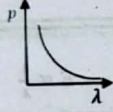
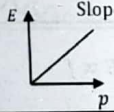
Two photons have energies 2 eV and 4 eV then the ratio between their wavelength is

- (a) 1: 2  
(b) 2: 1 ✓  
(c) 1: 1  
(d) 1: 4

**Solution:**

Since  $E \propto \frac{1}{\lambda}$   
So ratio in wavelength will be inverse ratio of energies

**Momentum of Photon:**

Momentum of photon in terms of frequency is given as	Momentum of photon in terms of wavelength is given as	Momentum of photon in terms of energy is given as
$p = \frac{hf}{c}$	$p = \frac{h}{\lambda}$	$p = \frac{E}{c}$
$p \propto f$	$p \propto \frac{1}{\lambda}$	$p \propto E$
		

**Number of Photons:**

If a beam of light contain 'n' number of photons then total energy of the beam is given as

$$E = nhf$$

Or

$$E = \frac{nhc}{\lambda}$$

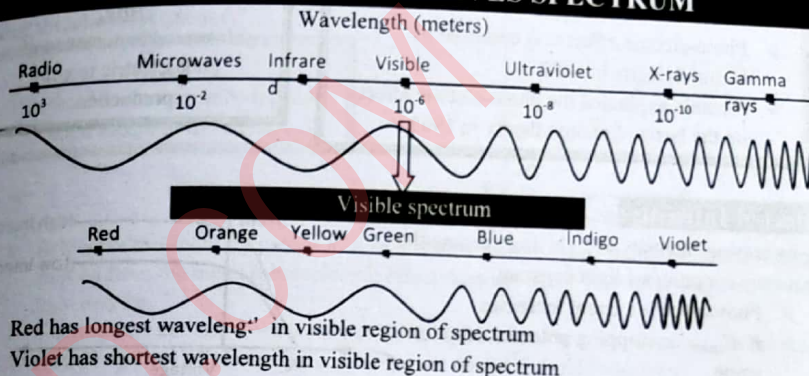
Or

$$E = npc$$

Relation with frequency	Relation with wavelength	Relation between momentum
$n = \frac{E}{hf}$	$n = \frac{E\lambda}{hc}$	$n = \frac{E}{pc}$
If two beams have same Energy $n \propto \frac{1}{f}$	If two beams have same Energy $n \propto \lambda$	If two beams have same Energy $n \propto \frac{1}{p}$

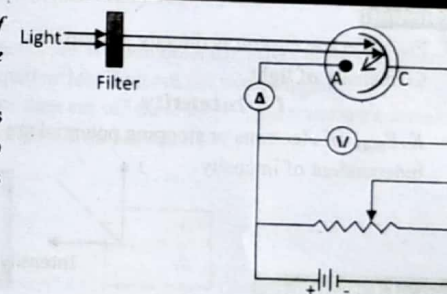
- Speed of photons in free space or vacuum is  $3 \times 10^8 \text{ ms}^{-1}$   
➤ Speed of photons in a medium depends upon wavelength

$$v \propto \lambda$$

**ELECTROMAGNETIC WAVES SPECTRUM****PHOTOELECTRIC EFFECT**

"Emission of electrons from surface of metal when exposed to light of suitable frequency is called photo-electric effect".

- Emitted electrons are known as photo electrons and current due to photo-electrons is known as photoelectric current.

**Stopping Potential:**

- By reversing the connections of battery (anode becomes -ve and cathode becomes +ve) electrons are repelled by anode and photo-electric current decreases.  
➤ "Negative potential at anode at which photoelectric current becomes zero is called stopping potential."  
➤ If  $V_0$  is stopping potential then maximum K.E of electrons is given as

$$K.E_{\max} = eV_0$$

**Example 1:** If stopping potential is 0.25V then  $K.E_{\max} = e(0.25V) = 0.25eV$

stopping potential =  $K.E_{\max}$  معلوم کرنے کے لیے

**Example 2:** If  $K.E_{\max}$  of electrons is 0.12eV then  $V_0 = \frac{0.12eV}{e} = 0.12V$

stopping potential =  $K.E_{\max}$  معلوم کرنے کے لیے

**Information**

- Photo-electric effect was observed by Heinrich Hertz in 1887.
- Einstein explained the photo-electric effect on the basis of photon theory in 1905.

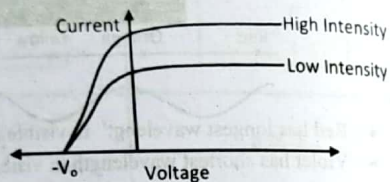
**Note:**

Inverse Phenomenon of photoelectric is x-ray production.

**Effect of Intensity:**

By increasing intensity of light and keeping the frequency (or color) of light constant.

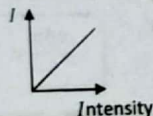
- Photoelectric current increases.
- $K.E_{max}$  or stopping potential remains same.

**Conclusion:**

- Photoelectric current is directly proportional to intensity of light.

$$I \propto \text{Intensity}$$

- $K.E_{max}$  of electrons or stopping potential are independent of intensity.



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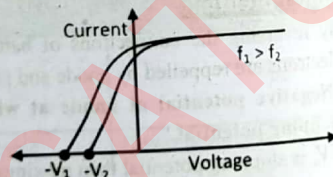
Intensity کو change کرنے کے لئے source اور cathode میں distance کو change کریں گے اور

$$\text{Intensity} \propto \frac{1}{(\text{distance})^2}$$

**Effect of Frequency:**

By increasing frequency of light while keeping the intensity constant.

- Photoelectric current remains same.
- $K.E_{max}$  of electrons or stopping potential increases.

**Conclusion:**

- Photoelectric current is independent of frequency of light.
- Stopping potential increases by increasing frequency and decreases by decreasing frequency.
- $K.E_{max}$  of electrons varies linearly with the frequency.

یاد رکھیں

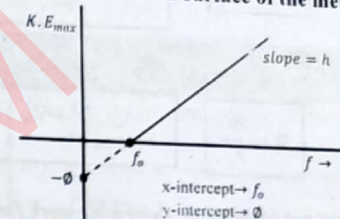
Frequency کو change کرنے کے لئے light کے colour کو change کریں گے۔

**Threshold Frequency ( $f_0$ ):**

"Minimum frequency of light required to emit the electrons from surface of the metal is called threshold frequency."

**Note:**

Threshold frequency only depends upon nature of the metal.



- Below the threshold frequency  $K.E$  of electrons will be  $-ve$ . Hence electrons will not be emitted from the metal (photoelectric effect does not occur) however large the intensity of light may be.
- Electrons are emitted from the metal surface (photoelectric effect does not occur) only when frequency of photon is equal or greater than threshold frequency.

**Cut off Wavelength: ( $\lambda_c$ )**

"Maximum wavelength of light required to emit the electrons from surface of the metal is called cut-off wavelength".

- Electrons are emitted from the metal surface (photoelectric effect does not occur) only when wavelength of photon is equal or less than cut off wavelength.
- If wavelength of photon is greater than cut off wavelength, electrons are not emitted from the metal surface (photo electric effect does not occur).

**Note:**

Cut-off wavelength only depends upon nature of the metal.

$$\lambda_c = \frac{c}{f_0}$$

**Work function: ( $\phi$ )**

"Minimum energy required to emit the electrons from the surface of metal is called work function".

**Note:**

Work function only depends upon nature of the metal

- Electrons are emitted from the metal surface (photoelectric effect does not occur) only when Energy of photon is equal or greater than work function.
- If Energy of photon is less than work function, electrons are not emitted from the metal surface (photo electric effect does not occur).

Metal	Work function (in eV)
Na	2.28
Al	4.08
Cu	4.70
Zn	4.31
Ag	4.73
Pt	6.35
Pb	4.14
Fe	4.50

- > Relation between threshold frequency and work function is

$$\phi = hf_0$$

(اگر  $f_0$  یا  $\phi$  دونوں میں سے کوئی ایک معلوم ہو تو اس relation دوسرے کو معلوم کر سکتے ہیں)

- > Relation between cut-off wavelength and work function is

$$\phi = \frac{hc}{\lambda_c}$$

(اگر  $\lambda_c$  یا  $\phi$  دونوں میں سے کوئی ایک معلوم ہو تو اس relation دوسرے کو معلوم کر سکتے ہیں)

Short cut formula to determine work function from cut off wavelength OR cut off wavelength from work function is

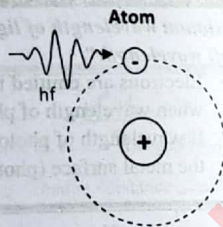
$$\phi = \frac{1240 \times 10^{-9}}{\lambda_c} \text{ eV}$$

### Einstein Explanation:

- > According to Einstein beam of light consists of stream of photons and energy of each photon is ' $hf$ ' and it only depends upon frequency.
- > According to Einstein: Intensity of light is directly proportional to number of photons.

$$\text{Intensity} \propto \text{no. of photons}$$

- ★ By increasing intensity number of photons increases thus current increases.



یاد رکھیں

ایک photon صرف ایک electron کو emit کرتا ہے

- > When a photon strikes an electron it transfers its energy to electron. Some amount of energy is used to remove the electron and rest amount of energy is given to electron as K.E.
- > Einstein's photo electric effect equation is based on conservation of energy and is given as

$$hf = K.E_{\max} + \phi \quad \text{OR} \quad K.E_{\max} = hf - \phi$$

Where

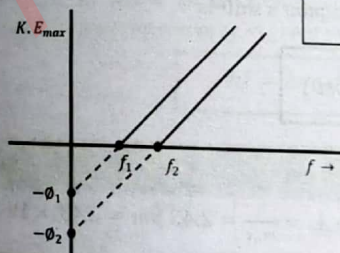
$$K.E_{\max} = eV_0 \text{ and } \phi = hf_0 = \frac{hc}{\lambda_c}$$

- ★ By increasing frequency of light  $K.E_{\max}$  increases thus stopping potential increases and vice versa.
- ★ By increasing work function or threshold frequency  $K.E_{\max}$  decreases thus stopping potential decreases and vice versa.

$K.E_{\max}$ and $V_0$ increases by	$K.E_{\max}$ and $V_0$ decreases by
(i). Increasing the energy or frequency of photon.	(i). Decreasing the energy or frequency of photon.
(ii). Decreasing the wavelength of photon.	(ii). Increasing the wavelength of photon.
(iii). By using a metal having larger work function of threshold frequency.	(iii). By using a metal having smaller work function of threshold frequency.
(iv). By using a metal having smaller cut off wavelength.	(iv). By using a metal having larger cut off wavelength.

### For two different metals

- > Slope of the graph remains same.
- >  $f_2 > f_1$

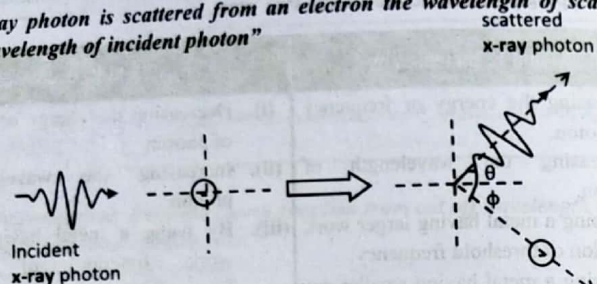


- X-intercept represents the threshold frequency
- Y-intercept represents the work function

Condition	Result
$f > f_0$ OR $E > \phi$ OR $\lambda < \lambda_c$	Photoelectric effect occur but $I = 0$ $K.E_{\max} = 0$ $V_0 = 0$
$f = f_0$ OR $E = \phi$ OR $\lambda = \lambda_c$	Photoelectric effect occur but $I \neq 0$ $K.E_{\max} \neq 0$
$f = f_0$ OR $E < \phi$ OR $\lambda > \lambda_c$	Photoelectric effect not occur $K.E_{\max} = 0$

## COMPTON'S EFFECT

"When an x-ray photon is scattered from an electron the wavelength of scattered photon is greater than wavelength of incident photon"



- When photon strikes with an electron it transfers some amount of its energy and momentum to electron that is why Scattered photon will have less energy, frequency and momentum than incident x-ray photon. (Wavelength of scattered photon is greater than incident photon)
- Compton's effect is best evidence for particle nature of light (photon theory).
- Change in wavelength between scattered and incident photon is called Compton's shift.
- By using law of conservation of energy and momentum formula derived for Compton's shift is and momentum formula derived for Compton's shift is

$$\Delta\lambda = \frac{h}{m_e c} (1 - \cos\theta)$$

## Compton's Wavelength:

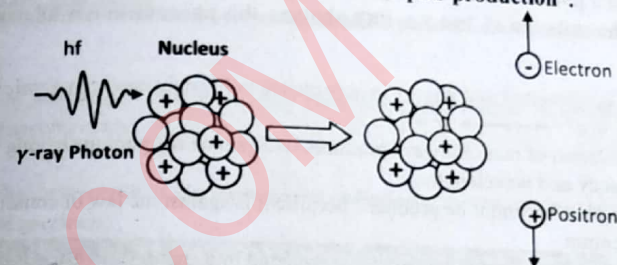
Quantity  $\frac{h}{m_e c}$  is known as Compton's wavelength  $\lambda_c = \frac{h}{m_e c} = 2.43 \text{ pm} = 2.43 \times 10^{-12} \text{ m}$ .

Scattering Angle	Compton's shift in terms of $\lambda_c$	Compton's shift in meter
$0^\circ$	$\Delta\lambda = 0$	$\Delta\lambda = 0$
$90^\circ$	$\Delta\lambda = \frac{h}{m_e c} = \lambda_c$	$2.43 \times 10^{-12} \text{ m}$
$180^\circ$	$\Delta\lambda = 2 \left( \frac{h}{m_e c} \right) = 2\lambda_c$	$4.86 \times 10^{-12} \text{ m}$

- Compton's shift is maximum for  $\theta = 180^\circ$

## PAIR PRODUCTION

"When a high energy  $\gamma$ -ray photon interacts with a heavy nucleus a pair of particle and its anti-particle is produced this phenomenon is known as pair production".



- In pair production a photon (energy) is converted into mass in accordance to Einstein equation  $E = mc^2$ .  $\gamma \rightarrow e^- + e^+$
- A photon cannot create a single electron or positron alone because it will violate the law of conservation of charge.
- Pair production cannot take place in vacuum (without interaction with nucleus) because it will violate the law of conservation of momentum. To conserve the momentum the pressure of nucleus is required.
- In order to create an electron-positron pair minimum energy  $2m_e c^2 = 1.02 \text{ MeV}$  is needed and surplus energy is given to electron and positron as K.E.

$$hf = 2m_e c^2 + (K.E.)_{e^-} + (K.E.)_{e^+}$$

Minimum energy of photon required	Minimum frequency of photon required	Maximum wavelength of photon required
$E_{\min} = 16.38 \times 10^{-14} \text{ J}$ $= 1.02 \text{ MeV}$	$f_{\min} = 2.47 \times 10^{20} \text{ Hz}$	$\lambda_{\max} = 1.21 \times 10^{-12} \text{ m}$

Example:

Pair production can not take place in vacuum because it is against:

- law of conservation of energy
- law of conservation of charge
- law of conservation of momentum ✓
- all of these

Example:

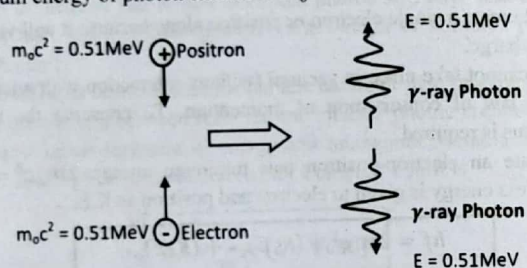
A gamma ray photon having energy 1.04 eV interacts with a heavy nucleus and an electron and positron are produced. The kinetic energy of produced electron will be:

- 0.04 eV
- 0.02 eV
- 0.01 eV ✓
- 0.1 eV

## ANNIHILATION OF MATTER

When a particle and its anti-particle combine with each other, they destroy each other with the emission of two  $\gamma$ -ray photons, this phenomenon is known as annihilation of matter."

- Mass is converted into energy in accordance to Einstein equation  $E=mc^2$ .  
 $e^- + e^+ \longrightarrow \gamma + \gamma$
- Annihilation of matter always produces two gamma ray photons having same energy, frequency and wavelength.
- Single photon cannot be produced because it is against the law of conservation of momentum
- Single electron or proton cannot be converted into energy because it is against the law of conservation of charge.
- Minimum energy of photon emitted is  $m_0c^2$ .

**Note:**

- Existence of Anti-particle was predicted by Dirac in 1928.
- Positron (Anti-particle of electron) was discovered by Anderson in 1932 from cosmic radiations

Minimum energy of photon emitted	Minimum frequency of photon emitted	Maximum wavelength of photon emitted
$E_{\min} = m_0c^2$	$f_{\min} = \frac{m_0c^2}{h}$	$\lambda_{\min} = \frac{h}{m_0c}$
$E_{\min} = 8.19 \times 10^{-14}\text{J}$ $= 0.51\text{MeV}$	$f_{\min} = 1.23 \times 10^{20}\text{Hz}$	$\lambda_{\min} = 2.43 \times 10^{-12}\text{m}$

## UNIT 12 &gt;&gt;

## ATOMIC SPECTRA

**Spectroscopy:**

The study of wavelength and intensity of electromagnetic radiations emitted or absorbed by atoms is called spectroscopy.

**Spectrum:**

Set of all the wavelength of electromagnetic radiations emitted or absorbed by a substance is called spectrum.

## TYPES OF SPECTRUM

**1. Line spectrum:**

- "Spectrum which consists of sharp lines with each line representing a specific wavelength emitted or absorbed by atoms is called line spectrum."
- Line spectrum is characteristics of emitting elements.
- Line spectrum is due to transition of electrons between energy levels within an atom.
- Each element has a unique set of energy levels, hence each element has a unique line spectrum.
- It is used to identify the gas or element.
- It is also known as atomic spectrum.

Line emission spectrum	Line absorption spectrum
Line spectrum of electromagnetic radiations emitted by a substance is called emission line spectrum	Line spectrum obtained by passing electromagnetic radiations through a substance is called absorption line spectrum
Each line represents the energy or wavelength emitted by the substance	Each line represents the energy or wavelength absorbed by the substance
Shows colored lines with a dark background	Shows dark lines with a bright background

**Band-spectrum:**

"Spectrum which consists of group of lines so closely spaced that each group appears to be a band is called band spectrum or molecular spectrum."

For example: Nitrogen spectrum

- > Band spectrum is produced when molecules radiate their rotational and vibrational energies.

## 2. Continuous-spectrum :

"Spectrum in which there is no gap or space between spectral lines is called continuous spectrum."

- > All the solids, liquids and very dense gases when heated produced continuous spectrum.

## HYDROGEN EMISSION SPECTRUM

When hydrogen gas is placed in a discharge tube and high voltage is applied across the tube the gas starts glowing and give off bluish red light.

There were five types of series observed in emission spectrum of hydrogen atom

### 1. Lyman Series:

- > Lyman series lies in ultraviolet region of spectrum.
- > Lyman series is produced when an electron jumps from higher energy level to 1<sup>st</sup> energy level.
- > The Rydberg formula for Lyman series is

$$\frac{1}{\lambda} = R_H \left( \frac{1}{1^2} - \frac{1}{n^2} \right)$$

Where  $n = 2, 3, 4, \dots$

**Minimum wavelength** of Lyman series is produced when electron jumps from infinite to 1<sup>st</sup> shell of hydrogen atom.

$$\lambda_{\min} = \frac{1}{R_H} = 91 \text{ nm}$$

**Maximum wavelength** of Lyman series is produced when electron jumps from 2<sup>nd</sup> to 1<sup>st</sup> shell of hydrogen atom.

$$\lambda_{\max} = \frac{4}{3R_H} = 122 \text{ nm}$$

### 2. Balmer Series:

- > Balmer series lies in visible region of spectrum.
- > Balmer series is produced when an electron jumps from higher energy level to 2<sup>nd</sup> energy level.
- > The Rydberg formula for Balmer series is

$$\frac{1}{\lambda} = R_H \left( \frac{1}{2^2} - \frac{1}{n^2} \right)$$

Where  $n = 3, 4, 5, \dots$

**Maximum wavelength** of Balmer series is produced when electron jumps from 3<sup>rd</sup> to 2<sup>nd</sup> shell of hydrogen atom.

$$\lambda_{\min} = \frac{4}{R_H} = 365 \text{ nm}$$

**Minimum wavelength** of Balmer series is produced when electron jumps from infinite to 2<sup>nd</sup> shell of hydrogen atom.

$$\lambda_{\max} = \frac{4}{3R_H} = 656 \text{ nm}$$

### 3. Paschan Series:

- > Paschan series lies in infrared region of spectrum.
- > Paschan series is produced when an electron jumps from higher energy level to 3<sup>rd</sup> energy level.
- > The Rydberg formula for Balmer series is

$$\frac{1}{\lambda} = R_H \left( \frac{1}{3^2} - \frac{1}{n^2} \right)$$

Where  $n = 4, 5, 6, \dots$

**Minimum wavelength** of Paschan series is produced when electron jumps from infinite to 3<sup>rd</sup> shell of hydrogen atom.

$$\lambda_{\min} = \frac{9}{R_H} = 820 \text{ nm}$$

**Maximum wavelength** of Balmer series is produced when electron jumps from 3<sup>rd</sup> to 2<sup>nd</sup> shell of hydrogen atom.

$$\lambda_{\max} = \frac{144}{7R_H} = 1874 \text{ nm}$$

### 4. Bracket Series:

- > Bracket series lies in infrared region of spectrum.
- > Bracket series is produced when an electron jumps from higher energy level to 4<sup>th</sup> energy level.
- > The Rydberg formula for bracket series is

$$\frac{1}{\lambda} = R_H \left( \frac{1}{4^2} - \frac{1}{n^2} \right)$$

Where  $n = 5, 6, 7, \dots$

**Minimum wavelength** of Bracket series is produced when electron jumps from infinite to 4<sup>th</sup> shell of hydrogen atom.

$$\lambda_{\min} = \frac{16}{R_H} = 1458 \text{ nm}$$

**Maximum wavelength** of Bracket series is produced when electron jumps from 5<sup>th</sup> to 4<sup>th</sup> shell of hydrogen atom.

$$\lambda_{\max} = 4050 \text{ nm} = \frac{400}{9R_H}$$

### 5. Pfund Series:

- > Pfund series lies in infrared region of spectrum.
- > Pfund series is produced when an electron jumps from higher energy level to 5<sup>th</sup> energy level.
- > The Rydberg formula for Pfund series is

$$\frac{1}{\lambda} = R_H \left( \frac{1}{5^2} - \frac{1}{n^2} \right)$$

Where  $n = 6, 7, 8, \dots$

**Minimum wavelength** of Pfund series is produced when electron jumps from infinite to 5<sup>th</sup> shell of hydrogen atom.

$$\lambda_{\min} = \frac{25}{R_H} = 2278 \text{ nm}$$

**Maximum wavelength** of Pfund series is produced when electron jumps from 6<sup>th</sup> to 5<sup>th</sup> shell of hydrogen atom.

$$\lambda_{\max} = \frac{900}{11R_H} = 7455 \text{ nm}$$

## BOHR'S MODEL

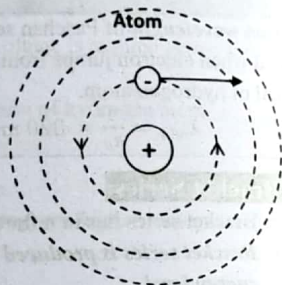
- > In order to explain empirical results obtained by Rydberg formulated a model of hydrogen atom.
- > Bohr's model is semiclassical model based on following postulates.

According to classical physics an accelerating charge such as orbiting electron must continuously radiate electromagnetic energy.

## Postulate I:

"Electron in an atom can move around nucleus in certain circular orbit without radiating. These orbits are called discrete stationary states of the atom."

Bohr's 1<sup>st</sup> postulate is contradiction of classical physics.



## Postulate II:

"Only those circular orbits or stationary states are allowed for which orbital angular momentum is an integral multiple of  $\frac{h}{2\pi}$ ."

$$L = n \left( \frac{h}{2\pi} \right) \quad \text{OR} \quad mvr = n \left( \frac{h}{2\pi} \right)$$

Where  $n$  is principle Quantum number and  $n = 1, 2, 3 \dots$

Example:

What is the ratio between angular momentum of electron in 1<sup>st</sup> and 3<sup>rd</sup> shell of hydrogen atom

- (a) 1:3 ✓                      (b) 3:1  
(c) 1:9                        (d) 9:1

Example:

In which of the following shell the electron in hydrogen atom will highest angular momentum

- (a) K-shell ( $n=1$ )            (b) L-shell ( $n=2$ )            (c) M-shell ( $n=3$ )            (d) N-shell ( $n=4$ ) ✓

Example:

Angular momentum of electron in 3<sup>rd</sup> shell of hydrogen atom is

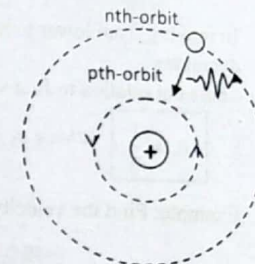
- (a)  $1.05 \times 10^{-34} \text{ J.s}$             (b)  $2.10 \times 10^{-34} \text{ J.s}$             (c)  $3.15 \times 10^{-34} \text{ J.s}$  ✓            (d)  $4.20 \times 10^{-34} \text{ J.s}$

1 <sup>st</sup> shell	2 <sup>nd</sup> shell	3 <sup>rd</sup> shell	4 <sup>th</sup> shell	5 <sup>th</sup> shell
$L = \frac{h}{2\pi} = \hbar$	$L = 2 \left( \frac{h}{2\pi} \right) = 2\hbar$	$L = 3 \left( \frac{h}{2\pi} \right) = 3\hbar$	$L = 4 \left( \frac{h}{2\pi} \right) = 4\hbar$	$L = 5 \left( \frac{h}{2\pi} \right) = 5\hbar$
$1.05 \times 10^{-34} \text{ J.s}$	$2.1 \times 10^{-34} \text{ J.s}$	$3.15 \times 10^{-34} \text{ J.s}$	$4.2 \times 10^{-34} \text{ J.s}$	$5.25 \times 10^{-34} \text{ J.s}$

## Postulate III:

"When an electron jumps from high energy state  $E_n$  to a low energy state  $E_p$  a photon of energy  $hf$  is emitted so that,"

$$hf = E_n - E_p$$



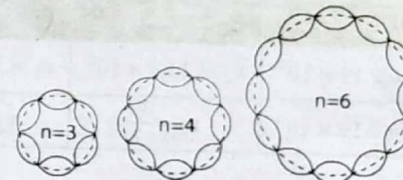
## De-Broglie's Interpretation

"According to De-Broglie electron in an orbit behave like a wave and produce stationary wave in the orbit. So length of orbit will be  $n\lambda$ ."

$$\ell = n\lambda$$

$$2\pi r = n \left( \frac{h}{mv} \right)$$

$$mvr = n \left( \frac{h}{2\pi} \right)$$



## Quantized Radii:

- > Electron can move in certain circular orbits.

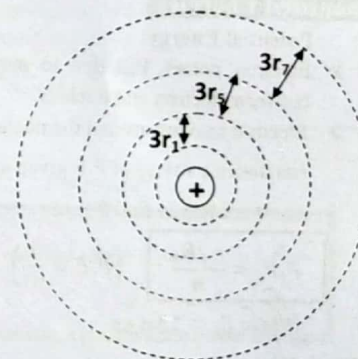
- > Radius of  $n$ th shell is given as

$$r_n = \frac{n^2 h^2}{4\pi^2 k m e^2}$$

$$r_n \propto n^2$$

- > Short cut relation to find radius

$$r_n = n^2 r_1 \quad \text{where } r_1 = 0.053 \text{ nm.}$$



1 <sup>st</sup> shell	2 <sup>nd</sup> shell	3 <sup>rd</sup> shell	4 <sup>th</sup> shell	5 <sup>th</sup> shell
$r_1$	$r_2 = 4r_1$	$r_3 = 9r_1$	$r_4 = 16r_1$	$r_5 = 25r_1$
0.053 nm	0.212 nm	0.477 nm	0.848 nm	1.325 nm

- > As ' $n$ ' increases radius of orbit increases and distance between two consecutive orbits are also increases.

**Quantized Velocity:**

Electron moving around the nucleus has discrete velocities.

- > Velocity of electron in  $n$ th-shell is given as

$$v_n = \frac{2\pi k e^2}{nh} \Rightarrow v_n \propto \frac{1}{n}$$

- > In moving from lower to higher shell velocity decreases  
> Short-cut relation to find velocity

$$v_n = \frac{v_1}{n} \text{ Where } v_1 = 2.19 \times 10^6 \text{ m/s}$$

Example: Find the velocity of electron in 3<sup>rd</sup> shell

$$v_3 = \frac{v_1}{3} = \frac{2.19 \times 10^6}{3} \text{ m/s} = 7 \times 10^5 \text{ m/s} = 7 \times 10^5 \text{ m/s}$$

First shell	2 <sup>nd</sup> shell	3 <sup>rd</sup> shell	4 <sup>th</sup> shell	5 <sup>th</sup> shell
$v_1 = 2.19 \times 10^6$	$v_2 = 1.09 \times 10^6$	$v_3 = 7.3 \times 10^5$	$v_4 = 5.5 \times 10^5$	$v_5 = 4.4 \times 10^5$
$v_1 = 2.19 \times 10^6$	$v_2 = \frac{v_1}{2}$	$v_3 = \frac{v_1}{3}$	$v_4 = \frac{v_1}{4}$	$v_5 = \frac{v_1}{5}$

**Quantized Energies:****(i). Potential Energy:**

- > Electron posses P.E due to attraction between electron and nucleus.  
> Electron moving around the nucleus

has discrete values of P.E given as :  $P.E_n = \frac{k q_1 q_2}{r_n} = \frac{k(e)(-e)}{r_n} = \frac{-ke^2}{r_n}$

- > Short relation to find P.E is

$$P.E_n = \frac{-2E_o}{n} \quad \left( P.E \propto \frac{1}{n^2} \right)$$

Where  $E_o = 13.6 \text{ eV}$

**(ii). Kinetic Energy:**

- > Electron posses kinetic energy due to its motion.  
> Electron moving around nucleus has discrete values of K.E.

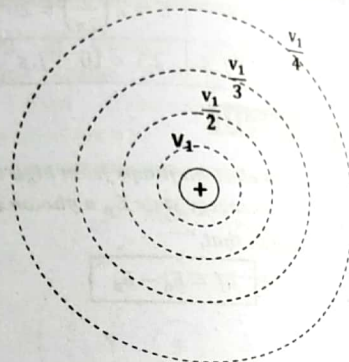
$$K.E_n = \frac{1}{2} m v_n^2 = \frac{ke^2}{2r_n}$$

**Note**

Orbital electrons have specific amount of energies where as free electron can have any amount of energy.

**Note**

By increasing  $n$  P.E increases.



- > Short cut relation to find K.E is

$$K.E_n = \frac{E_o}{n^2} \Rightarrow K.E_n \propto \frac{1}{n^2}$$

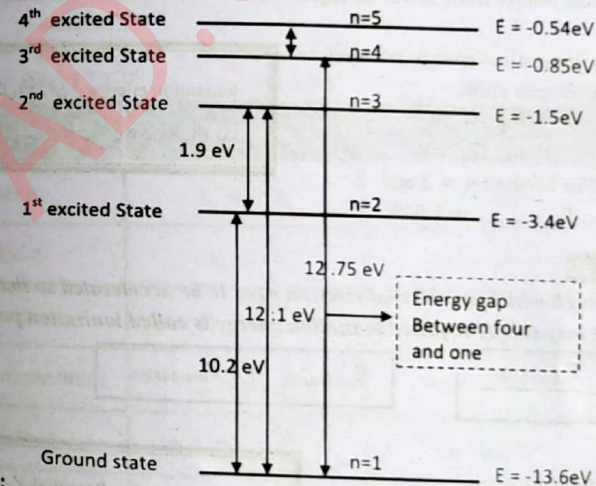
**(iii). Total Energy:**

- > T.E of electron is given as  $E_n = P.E_n + K.E_n = \frac{-ke^2}{r_n} + \frac{ke^2}{2r_n} = \frac{-ke^2}{2r_n} = \frac{-2\pi k^2 m e^4}{n^2 h^2}$

- > Short relation to find energy of electron

$$E_n = \frac{-E_o}{n^2} \quad \left( E_n \propto \frac{-1}{n^2} \right)$$

- > Ratio between K.E and total energy of electron is always 1 : -1  
> Ratio between K.E and total energy of electron is always 2 : 1  
> Ratio between K.E and P.E energy of electron is always 1 : -2

**Example 2:**

P.E of electron in ground state will be.

- (a) 13.6 eV (b) -13.6 eV  
(c) -27.2 eV (d) zero eV

**Answer:**

For ground state  $n = 1$  and  $E = -13.6 \text{ eV}$   
so  $P.E = 2(-13.6 \text{ eV}) = -27.2 \text{ eV}$

**Example 1:** What is K.E of electron in 1<sup>st</sup> excited state.

- (a) 13.6 eV (b) 3.4 eV  
(c) 10.2 eV (d) 12.1 eV

**Answer:**

For 1<sup>st</sup> excited state  $n = 2$  and  
 $E = -3.4 \text{ eV}$  so  $K.E = +3.4 \text{ eV}$

کسی بھی shell میں الیکٹران کی potential energy اس کی ٹوٹل انرجی سے دو گنا ہوگی۔

کسی بھی shell میں الیکٹران کی K.E اس کی ٹوٹل انرجی کے برابر ہوگی لیکن positive ہوگی۔

First shell	2 <sup>nd</sup> shell	3 <sup>rd</sup> shell	4 <sup>th</sup> shell	5 <sup>th</sup> shell
$-E_0$	$-\frac{E_0}{4}$	$-\frac{E_0}{9}$	$-\frac{E_0}{16}$	$-\frac{E_0}{25}$
-13.6 eV	-3.4 eV	-1.51 eV	-0.85 eV	-0.54 eV

**Ionization Energy:**

"Energy required to remove the electron from an atom is called ionization energy."

- > It is the energy required to make the electron jump from present state to infinite state.
- > Ionization energy of electron in nth shell is given as

$$E_{\text{ionization}} = \frac{+E_0}{n^2} \quad \text{or} \quad E_{\text{ionization}} = \frac{13.6 \text{ eV}}{n^2} \quad \left( E_{\text{ionization}} \propto \frac{1}{n^2} \right)$$

- > When an electron jumps from lower to higher orbit 'n' increases and ionization energy decreases.

**Example 3:** What is ionization energy of electron moving in M-shell of hydrogen atom.

- > (a) 13.6 eV (b) 3.4 eV
- > (c) 1.5 eV (d) 12.1 eV
- > **Answer:** For M-shell  $n = 3$  and  $E = -1.5 \text{ eV}$  so  $E_{\text{ionization}} = 1.5 \text{ eV}$

کئی بھی shell میں الیکٹران کی ionization energy اس کی ٹوٹل انرجی کے برابر ہوگی لیکن positive ہوگی۔

**Ionization Potential:**

"Potential through which an external electron need to be accelerated so that on collision with bound electron it may supply required ionization energy is called ionization potential."

$$V_{\text{ionization}} = \frac{E_{\text{ionization}}}{e} \quad \text{or} \quad E_{\text{ionization}} = e V_{\text{ionization}}$$

**Example 4:**

Minimum potential required to accelerate an external electron so that it may knock out the electron for 1<sup>st</sup> excited state.

- (a) 13.6 V (b) 3.4 V
- (c) 1.5 eV (d) 1.5 V

**Answer:** For 1<sup>st</sup> excited state  $n = 2$  and  $E = -3.4 \text{ eV}$   
so  $E_{\text{ionization}} = 3.4 \text{ eV}$  and  $V_{\text{ionization}} = 3.4 \text{ V}$

**Excitation Energy:**

- > "Energy required to make the electron jump from lower state to higher energy state is called excitation energy."
- > Minimum energy required to excite an atom is called excitation energy.

$$E_{\text{excitation}} = E_{\text{final}} - E_{\text{initial}}$$

**Example 5:** Energy required to excite the hydrogen atom from ground state ( $n = 1$ ) to 2<sup>nd</sup> excited state ( $n = 3$ ) is

- (a) 10.2 eV (b) 1.5 eV
- (c) 12.1 eV (d) 3.4 eV

**Answer:**  $E_{\text{exc}} = 13.6 - 1.5 = 12.1 \text{ eV}$

**Excitation Potential:**

"Minimum potential through which an external electron need to be accelerated so that on collision with bound electron it may supply the required energy is called excitation potential."

$$V_{\text{excitation}} = \frac{E_{\text{excitation}}}{e}$$

**Example 6:** Minimum potential required to excite the atom from ground state to first excited state is

- (a) 10.2 V (b) 1.5 V
- (c) 12.1 V (d) 3.4 V

Quantity	Relation	Electron jumps from lower to higher state	Electron jumps from higher to lower state
Radius	$r_n = n^2 r_1$	Increases	Decreases
Velocity	$V_n = \frac{V_1}{n}$	Decreases	Increases
Momentum	$P_n = \frac{mV_1}{n}$	Decreases	Increases
Angular momentum	$L_n = n \left( \frac{h}{2\pi} \right)$	Increases	Decreases
K.E	$K.E_n = \frac{+E_0}{n^2}$	Decreases	Increases
P.E	$P.E_n = \frac{-2E_0}{n^2}$	Increases	Decreases
Total Energy	$E_n = \frac{-E_0}{n^2}$	Increases	Decreases
Ionization Energy	$I.E_n = \frac{+E_0}{n^2}$	Decreases	Increases
Excitation Energy	$E_{\text{ex}} = E_n - E_p$	Decreases	Increases
Time Period	$T_n \propto n^3$	Increases	Decreases

## SPECTRAL SERIES

When an electron jumps from high energy state  $E_n$  to a low energy state  $E_p$  a photon of energy  $hf$  is emitted so that,

$$hf = E_n - E_p$$

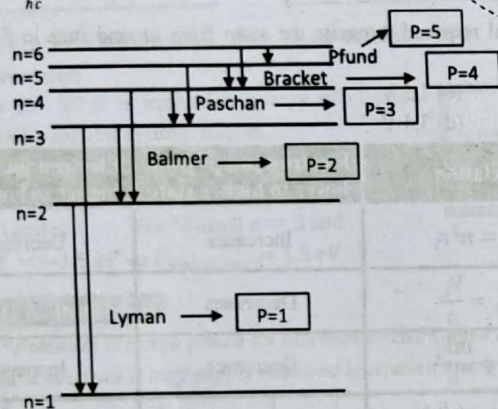
$$\frac{hc}{\lambda} = -\frac{E_0}{n^2} - \left(-\frac{E_0}{p^2}\right)$$

$$\frac{hc}{\lambda} = \frac{E_0}{p^2} - \frac{E_0}{n^2}$$

$$\frac{1}{\lambda} = \frac{E_0}{hc} \left(\frac{1}{p^2} - \frac{1}{n^2}\right)$$

$$\frac{1}{\lambda} = R_H \left(\frac{E_0}{p^2} - \frac{E_0}{n^2}\right)$$

Where  $R_H = \frac{E_0}{hc} = 1.0974 \times 10^7 \text{ m}^{-1}$



Series Name	Transition From Higher shell to	Maximum Wavelength	Minimum Wavelength	Region
Lyman	1 <sup>st</sup> shell $P = 1$	$\lambda_{\max} = \frac{4}{3R_H}$ $= 122 \text{ nm}$	$\lambda_{\min} = \frac{1}{R_H}$ $= 91 \text{ nm}$	Ultraviolet
Balmer	2 <sup>nd</sup> shell $P = 2$	$\lambda_{\max} = \frac{36}{5R_H}$ $= 656.1 \text{ nm}$	$\lambda_{\min} = \frac{4}{R_H}$ $= 365 \text{ nm}$	Visible
Paschen	3 <sup>rd</sup> shell $P = 3$	$\lambda_{\max} = \frac{144}{7R_H}$ $= 1874 \text{ nm}$	$\lambda_{\min} = \frac{9}{R_H}$ $= 820 \text{ nm}$	Infrared
Brackett	4 <sup>th</sup> shell $P = 4$	$\lambda_{\max} = \frac{400}{9R_H}$ $= 4050 \text{ nm}$	$\lambda_{\min} = \frac{16}{R_H}$ $= 1458 \text{ nm}$	Infrared
Pfund	5 <sup>th</sup> shell $P = 5$	$\lambda_{\max} = \frac{900}{11R_H}$ $= 7455 \text{ nm}$	$\lambda_{\min} = \frac{25}{R_H}$ $= 2278 \text{ nm}$	Infrared

## UNIT 13 &gt;&gt;

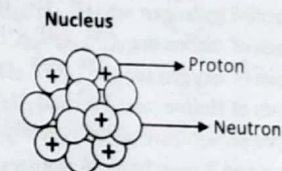
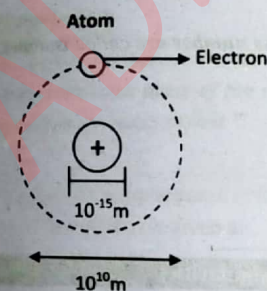
## NUCLEAR PHYSICS

- > Rutherford discovered the nucleus and protons.
- > Rutherford predicted the existence of neutrons.
- > Chadwick discovered the neutrons.

## Atomic Nucleus:

"At the center of each atom there is massive and positively charged nucleus containing protons and neutrons."

- > About 99.9% mass of an atom is concentrated in the nucleus.
- > Size of nucleus is  $10^{-14} - 10^{-15}$  times smaller than atom.
- > Volume of nucleus is  $10^{12} - 10^{15}$  times smaller than atom.



## Unified atomic mass unit:

"One twelfth of mass of carbon-12 is called unified atomic mass unit."

$$1u = \frac{\text{mass of C-12}}{12} = 1.6606 \times 10^{-27} \text{ kg}$$

$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg} = 1.007276u$$

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg} = 1.008665u$$

$$\text{Mass of electron} = 9.1 \times 10^{-31} \text{ kg} = 0.00055u$$

## Atomic Number:

"The number of protons in a nucleus is called atomic number."

- > Elements are identified by their atomic number.
- > Atomic number is also known as charge number and it identifies the charge of nucleus.

$$\text{Charge} = Ze$$

For Example atomic number of alpha particle is 2 so its charge will be  $(+2e)$ .

**Mass Number:**

"The total number of protons and neutrons in a nucleus is called its mass number."

- Mass number identifies the mass of the nucleus for example mass number of oxygen is 16 so its mass will be 16u.

$$A = Z + N$$

**Symbol of Nucleus:**

Nucleus is represented by symbol  ${}_Z^AX^A$ .

- Superscript 'A' represents the mass number of total number of nucleus in the nucleus.
- Subscript 'Z' represents the atomic number or total number of protons in the nucleus.

For example symbol for uranium is  ${}_{92}^{238}\text{U}$

$$\text{No. of nucleus} = 238$$

$$\text{No. of protons} = 92$$

$$\text{No. of neutrons} = 238 - 92 = 146$$

**Isotopes:**

"Atoms having same atomic number but different mass number are called isotopes."

- Isotopes of hydrogen are  ${}_1\text{H}^1$ ,  ${}_1\text{H}^2$ ,  ${}_1\text{H}^3$
- Isotopes of carbon are  ${}_6\text{C}^{12}$ ,  ${}_6\text{C}^{13}$ ,  ${}_6\text{C}^{14}$
- Isotopes of oxygen are  ${}_8\text{O}^{16}$ ,  ${}_8\text{O}^{17}$ ,  ${}_8\text{O}^{18}$
- Isotopes of Helium are  ${}_2\text{He}^3$  and  ${}_2\text{He}^4$
- Isotopes of Neon are  ${}_{10}\text{Ne}^{20}$ ,  ${}_{10}\text{Ne}^{21}$ ,  ${}_{10}\text{Ne}^{22}$
- Cesium and Xenon have 36 isotopes.

Similarities	Dissimilarities
(i). Same atomic no.	(i). Different mass no.
(ii). Same no. of protons	(ii). Different no. of neutrons
(iii). Same no. of electrons	(iii). Different mass
(iv). Same chemical properties	(iv). Different physical
(v). Same position in periodic table	

**Isobars:**

"Nuclei having same mass no. but different atomic no. are called isobar."

- ${}_1\text{H}^3$  and  ${}_2\text{He}^3$  are isobars.
- ${}_6\text{C}^{14}$  and  ${}_7\text{N}^{14}$  are isobars.

**Isotones:**

"Nuclei having same no. of neutrons are called isotones."

- ${}_6\text{C}^{13}$  and  ${}_7\text{N}^{14}$  are isotones.
- ${}_1\text{H}^3$  and  ${}_2\text{He}^4$  are isotones.

یاد رکھیں

Mass کے علاوہ باقی کچھ بھی same نہیں ہو گا۔

یاد رکھیں

Neutrons کی تعداد کے سوا باقی کچھ بھی same نہیں ہو گا۔

**Isodiphers:**

"Nuclei for which the difference between neutrons and protons is same are called isodiphers."

**Example:**

$${}_6\text{H}_2^3 (2 - 1 = 1) \text{ and } {}_6\text{H}_7^{13} (7 - 6 = 1) \text{ are isodiphers.}$$

**Mass Spectrograph:**

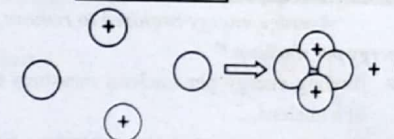
"Mass spectrograph is a device which is used to separate the isotopes and to determine their masses and abundances."

- Charged isotopes are accelerated through p.d.V they gain  $K.E = qV$  and  $V = \sqrt{\frac{2qV}{m}}$
- Then they are projected in magnetic field which exerts a deflecting force which bends in a circular path of different radii depending on their masses.  $r \propto \sqrt{m}$
- By measuring their masses by using the relation

$$m = \frac{B^2 r^2 q}{2V}$$

**Mass-defect:**

"The difference between total mass of nucleus and experimental mass of the nucleus is called mass defect or mass deficit."



- Loss in mass appears in the form of energy according to Einstein's Equations  $E = \Delta mc^2$ . Mass-defect is given as

$$\Delta m = Zm_p + (A - Z)m_n - m_{\text{Nucleus}}$$

- Mass-defect increases from H to U (جتنی زیادہ Nucleus کی جگہ mass-defect بڑھتا ہے)

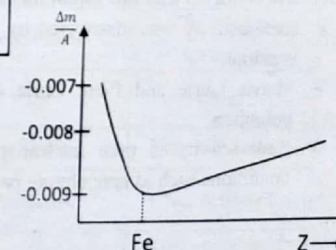
$$\Delta m = 2m_p + 2m_n - m_{\text{He}}$$

**Mass-defect per nucleon:  $\left(\frac{\Delta m}{A}\right)$** 

- Mass-defect per nucleon is also known as packing fraction.
- Mass-defect per nucleon or packing fraction measures the stability of a nucleus.

$$\text{Stability} \propto \frac{\Delta m}{A}$$

- $\frac{\Delta m}{A}$  increases from H to Fe
- $\frac{\Delta m}{A}$  is maximum for  ${}_{26}\text{Fe}$
- $\frac{\Delta m}{A}$  decreases from Fe to U



**Binding Energy:**

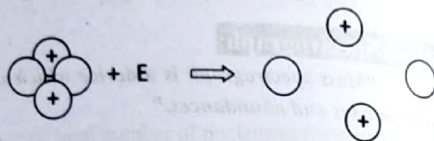
"Energy required to break the nucleus into its constituents protons and neutrons is called binding energy."

- Energy appears in increase in mass.
- Binding energy of a nucleus is given as

$$E_B = \Delta mc^2$$

OR

$$E_B = [Zm_p + (A - Z)m_n - m_{\text{Nucleus}}]c^2$$



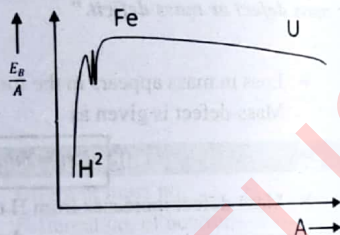
- Binding energy increases from H to U.

(جتنی زیادہ binding انرژی ہوگا، U سے زیادہ H تک)

**Binding Energy Per Nucleon:**

"Average energy required to remove a single nucleon from the nucleus is called binding energy per nucleon."

- Binding energy per nucleon measures the stability of a nucleus.
- Binding energy per nucleon increases from H to Fe.
- Binding energy per nucleon is maximum for ( ${}^{56}\text{Fe}$ ) and its value is 8.8 Mev.
- Binding energy per nucleon decreases from Fe to U.
- For  $U^{238}$  binding energy per nucleon curve rises, products are more stable than reactants and energy is emitted (e.g. fission and fusion).

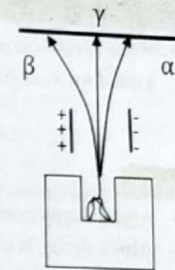
**RADIOACTIVITY**

"Unstable isotopes or elements emit radiations spontaneously these elements are known as radioactive elements and this phenomenon is known as radioactivity."

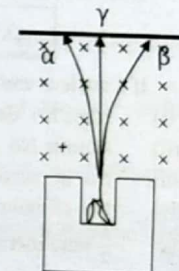
- Radioactivity was discovered by Henry Becquerel in 1896 by observing radiations from uranium.
- Marrie Curie and Piere Curie discovered two new radioactive elements radium and polonium.
- Radioactivity is pure nuclear phenomenon and it is independent of other physical conditions such as temperature pressure, electric and magnetic field etc.

**Types of radiations:****In presence of electric field**

- Radiations are of three types  $\alpha$ ,  $\beta$  and  $\gamma$ .
- $\gamma$ -rays pass straight showing that they are neutral.
- $\beta$ -rays are deflected towards +ve plate showing that they are negatively charged.
- $\alpha$ -rays are less deflected showing that they are massive and  $\beta$ -rays are more deflected showing that they are lighter.

**In presence of magnetic field:**

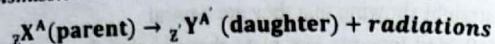
- $\gamma$ -rays are **not** deflected by magnetic field because they are neutral.
- $\alpha$  and  $\beta$  rays are deflected in opposite directions because they are oppositely charged.
- $\alpha$  is less deflected than  $\beta$  because  $\alpha$  is massive than  $\beta$ .

**Properties of rays:**

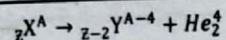
Features	$\alpha$ -rays	$\beta$ -rays	$\gamma$ -rays
Nature	Helium Nuclei	Electrons or positrons	E.M. photons
Typical source	Radon-222	Strontium-94	Cobalt-60
Mass No.	$A = 4$	$A = 0$	$A = 0$
Charge No.	$Z = 4$	$Z = -1 \text{ or } +1$	$Z = 0$
Mass	$4u \text{ or } 4m_p$	$m_e$	Mass less
Charge	$+2e$	$-e \text{ or } +e$	zero
Speed	$\sim 10^7 \text{ m/s}$	$\sim 10^8 \text{ m/s}$	$\sim 3 \times 10^8 \text{ m/s}$
Penetration power / Range (in air)	Several centimeter	Several meter	Obey inverse square law
Ionizing ability (ions in pair in air per mm)	$\sim 10^4$	$\sim 10^2$	$\sim 1$
Energy spectrum	Line and discrete	Continuous	Line and discrete
Effect of electric or magnetic field	Deflected	Deflected	Not deflected
Absorbed by	A paper	1-5 mm Al sheet	1-10 cm of lead sheet

## NUCLEAR TRANSMUTATION

"Conversion of parent nucleus into a daughter nucleus by emission of radiations is called nuclear transmission or nuclear decay or nuclear disintegration."

 **$\alpha$ -decay:**

- Alpha decay occurs with nuclei that are too large to be stable.
- Alpha decay is caused by coulomb repulsion.
- General reaction for  $\alpha$ -decay is



- If a nucleus emits an alpha particle its

- Mass No. decreases by 4.
- Atomic No. decreases by 2.
- No. of protons decreases by 2.
- No. of neutrons decreases by 2.
- $\frac{N}{Z}$  ratio increases.

 **$\beta$ -decay:**

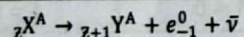
- Beta decay is caused by weak nuclear force.

- There are three types of  $\beta$ -decay

(i) -ve beta ( $\beta^-$ )      (ii) +ve beta ( $\beta^+$ )

(iii) electron capture

- General reaction for  $\beta^-$  is



- If a nucleus emits a  $\beta^-$  particle its

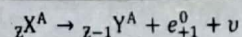
- Mass No. remain same.
- Atomic No. increases by one.
- No. of neutrons decreases by one.
- No. of protons increase by one

**Note**

$\beta^-$  is due to neutron decay into a proton, electron and anti-neutrino  
 ${}_0^1 n \rightarrow {}_1^1 H + e_{-1}^0 + \bar{\nu}$

**Positive Beta decay:**

- General reaction for  $\beta^+$  is



- If a nucleus emits a  $\beta^+$  (positron) its

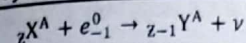
- Mass No. remains same.
- Atomic No. decreases by one
- No. of protons decreases by one.
- No. of neutrons increases by one.

**Note**

$\beta^+$  is due to proton decay into a neutron, positron and anti-neutrino  
 ${}_1^1 H \rightarrow {}_0^1 n + e_{+1}^0 + \nu$

**Electron capture:**

For few nuclei electron usually from K-shell is captured by nucleus



- If a nucleus captures an electron its
- Mass No. remains same.
  - Atomic No. decreases by one
  - No. of protons decreases by one.
  - No. of neutrons increases by one.

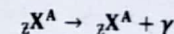
**Note**

Neutrino ( $\nu$ ) and anti-neutrino ( $\bar{\nu}$ ) have zero charge and approximately zero mass.

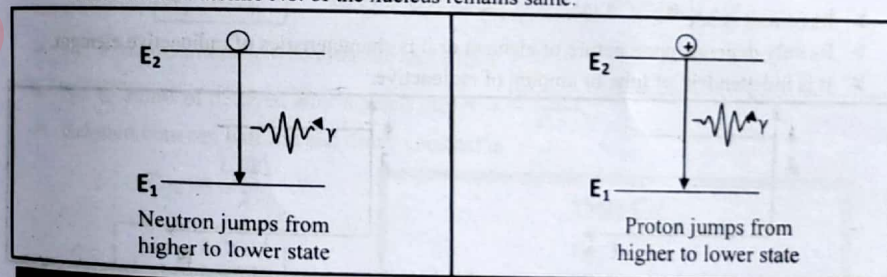
**Gamma Decay:**

Gamma rays are photons just like ultraviolet and X-rays and only differs on the basis of its origin or energy.

- As there are energy levels for electrons in an atom similarly there are energy levels for nucleons in a nucleus.
- Energy gap between nuclear levels are of order of MeV but in case of atoms energy gaps are only few electron volt.
- When a nucleus is excited (a nucleon jumps from low energy state to higher energy state) it can decay to ground state by emission of  $\gamma$ -ray photon.
- General reaction for  $\gamma$ -decay is



Mass No. and atomic No. of the nucleus remains same.

**HALF LIFE**

"Time in which half no. of radioactive element decay is called its half life"

**Random process:**

A process without defined pattern, rule or method is called random process. Nuclear decay is random process because it is unpredictable that which atom when will decay.

**Spontaneous Process:**

A process occurring without apparent external cause is called spontaneous process. Nuclear decay is spontaneous process it cannot be speeded up or slowed down by physical and chemical means.

➤ Since individual disintegrations are random, however the probability of decay (half life) in a sample has fixed value which is characteristic of that material.

1. "No radioactive element can completely decay or infinite time is required for all the atoms to decay".

2. **Rate of decay:** According to Rutherford and Soddy law for radioactive decay:  
"Rate of decay of an element at any instant is directly proportional to number of atoms present at that instant".

$$\frac{\Delta N}{\Delta t} \propto -N$$

$$\frac{\Delta N}{\Delta t} \propto -\lambda N$$

If  $N_0$  are number of atoms at  $t = 0$  then number of atoms at any instant  $t$  are given as

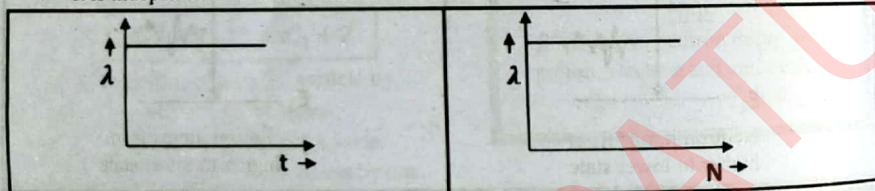
$$N = N_0 e^{-\lambda t}$$

**Decay Constant ( $\lambda$ ):**

"Fractional decay per second is known as decay constant or disintegration constant."

$$\lambda = \frac{\Delta N/N}{\Delta t}$$

- Its SI unit is  $\text{sec}^{-1}$ .
- Its only depends upon nature of element or it is characteristics of radioactive element.
- It is independent of time or amount of radioactive.

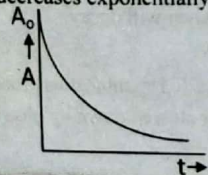


**Activity:** "No. of disintegrations per second is called activity or rate of decay."

$$A = \lambda N$$

$$\text{OR } A = A_0 e^{-\lambda t}$$

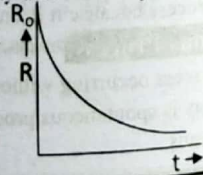
Activity decreases exponentially with time.



$$R = \lambda N$$

$$\text{OR } R = R_0 e^{-\lambda t}$$

Rate of decay decreases exponentially with time.



Activity or rate of decay depends upon time, No. of atoms and nature of radioactive element.

- SI unit of activity is Becquaral:  $1 \text{ Bq} = \text{one disintegration per sec}$
- A common unit of activity is curie:  
 $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq} = 3.7 \times 10^{10} \text{ disintegration per sec}$

**Half life:**

- Half life of a radioactive element only depends upon nature of element and independent of time and no. of atoms.
- After each half life no. of atoms will become half of its initial value.

No. of half lives	1	2	3	4	5
Fraction remain undecayed	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$
Fraction decayed	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{31}{32}$

(اوپر والے table کی مدد سے اگر half-life کی تعداد دی ہو تو fraction معلوم کر سکتے ہیں یا اگر fraction دی ہو تو half-life کی تعداد معلوم کر سکتے ہیں۔)

**Note**

One curie is approximately equal to activity of one gram of radium.

If 't' is total time for 'n' half lives then

$$t = n T_{1/2}$$

(اگر کوئی دو چیزیں معلوم ہوں تو اس فارمولے سے تیسری معلوم کریں)

- No. of atoms of undecayed after nth half life:  $N = \frac{N_0}{2^n}$
- No. of atoms of decayed after nth half life:  $N = \frac{(2^n - 1)N_0}{2^n}$
- Relation between half life and decay constant is

$$T_{1/2} = \frac{\ln(2)}{\lambda}$$

$$\text{OR } T_{1/2} = \frac{0.693}{\lambda}$$

**Short Cut**

$$T_{1/2} = \frac{0.7}{\lambda}$$

اگر دونوں میں سے کوئی ایک معلوم ہو تو اس فارمولے سے دوسری کو معلوم کریں۔

**Mean life:**

Time in which 63% of a radioactive element is decayed is known as mean life.

$$\text{mean life} = T^* = \frac{1}{\lambda}$$

- $T^* = \frac{T_{1/2}}{0.693} = 1.44 T_{1/2}$
- Mean life is about 44% more than half life.

Isotope	Half life	Isotope	Half life
Uranium-238	$4.5 \times 10^9$ years	Sodium-24	15 hours
Radium-226	1620 years	Iron-59	45 days
Uranium-239	23.5 minutes	Technetium-99	6 hours
Radon	3.8 days	Iodine-125	60 days
Iodine-131	8 days	Plutonium	24000 years

## RADIATION EXPOSURE

### Back ground radiations:

- "Radiations present in the environment whose source unknown is are called back ground radiations."
- Background radiations varies from place to place.
- Source of background radiation are
  - Cosmic radiations
  - Radioactive substance in earth's crust.
  - Building materials containing small amount of radioactive substance.
  - Radioactive radon gas enters buildings from ground.
  - All types of food contain small amount of radioactive substance common are potassium-40 and carbon-14 isotopes.
  - Radiations added in environment by human activities such as medical practices diagnostic x-rays.
  - Other sources include radioactive waste from nuclear facilities, hospitals and research centers, colour T.V, luminous watches and tobacco leaves.

### Cosmic Radiations:

"Radiations coming from outer space to earth in form of high energy electromagnetic radiations and charged particles are called cosmic rays."

- Atmosphere acts as a shield to absorb some of these radiations.
- Ozone layer absorb ultraviolet radiations which causes eye and skin diseases.
- Recently a depletion in ozone layer was observed due to a chemical chloro-floro carbon which is used in aerosol sprays, refrigeration, paints and foam industry.

## BIOLOGICAL EFFECTS OF RADIATIONS

### Absorbed dose:

"The energy  $E$  absorbed from ionizing radiation per unit mass  $m$  of the absorbing body is called absorbed dose."

$$D = \frac{E}{m}$$

- Its SI unit is gray ( $1\text{Gy} = 1/\text{kg}^{-1}$ ).
- Its old unit is "rad" (radiation absorbed dose)  
 $1\text{rad} = 0.01\text{Gy}$  or  $1\text{Gy} = 100\text{rad}$
- Equal dose of different radiations don't produce same biological effect.
- Biological effect depends upon two factors
  1. Types of radiation
  2. The part of body absorbing radiation.
- Neutrons are more damaging to eyes than other parts of body.
- For same absorbed dose  $\alpha$ -rays are 20 times more damaging than x-rays.

### Equivalent Dose:

"The product of absorbed dose and RBE (relative biological effectiveness) of the kind of radiation being absorbed is called equivalent dose."

$$D_e = D \times RBE$$

- Its SI unit is sievert (Sv):  $1\text{Sv} = 1\text{Gy} \times RBE$
- Its old unit is "rem" (Rontgen equivalent mass)  
 $1\text{rem} = 0.01\text{Sv}$  or  $1\text{Sv} = 100\text{rem}$
- Background radiation to which we expose on average is 2mSv per year.
- Doses of 3Sv will cause radiation burn to the skin weekly dose of 1mSv is consider to be safe for the workers of nuclear facilities or mines.

Dosage in microsievert	Effect	Dosage in microsievert	Effect
$1 \times 10^6$	Radiation sickness	$2.5 \times 10^6$	Sterility for about two years
$1.5 \times 10^6$	Temporary low fertility	$4 \times 10^6$	Death of 60% of people exposed

- The damage from  $\alpha$ -particle is small until it enters the body.
- $\alpha$  and  $\beta$  particles cause redness and sores on the skin.

Low level radiation effects	High level radiation effect
<ul style="list-style-type: none"> <li>• Loss of hair</li> <li>• Ulceration</li> <li>• Stiffening of lungs</li> <li>• Drop in white blood cells which results in sickness pattern of diarrhea, vomiting and fever known as radiation sickness.</li> </ul>	<ul style="list-style-type: none"> <li>• Disrupt blood cells seriously lead to anemia and leukemia</li> <li>• Chromosome abnormalities or mutation may cause delayed genetic effects such as cancer and eye cataracts and abnormalities in future generation.</li> </ul>

## BIOLOGICAL AND MEDICAL USES OF RADIATIONS

- Radioisotopes are used to find out what happens in many complex chemical reactions and how they proceed.
- In biological, they have helped in investigating into chemical reactions that take place in plants and animals.
- Radio active isotopes are used to determine proper amount of fertilizer taken up by plant.
- Radiation induced mutation improved varieties of crops. Such as rice, chickpea, wheat and cotton etc.

### Radio active Tracer:

*"Tracer technique is to substitute radioactive atoms for stable atoms of same kind and then follow the radioactive atoms with the help of radiation detector. These radioactive elements are known as radioactive tracers."*

- In medicine, tracers are used to detect malignant tumors.
- In agriculture, tracers are used to study the uptake of a fertilizer.
- Tracers are used to identify faults in underground pipes.

Radioactive Element	Isotope	Use in medicine
Iodine	I-131	Mostly absorbed in thyroid gland ∴ Hyper active gland absorb more than twice amount of iodine than normal gland • Used for treatment of thyroid gland cancer
Phosphorous	P-32	Mostly absorbed by bones used for treatment of skin cancer.
Cobalt	Co-60	Mostly absorbed by liver used for treatment of cancer.
Sodium	Na-24	It is uniformly distributed throughout the body and used to study the circulation of blood.
Strontium	Sr-90	Used for treatment of skin cancer.

- The  $\gamma$ -rays radiograph is used in medical diagnosis such as internal imaging of brain and determine precisely the size and location of tumors.

## BASIC FORCES OF RADIATIONS

- Basic forces of nature are:
  1. Gravitational force
  2. Magnetic force
  3. Electric force
  4. Weak nuclear force
  5. Strong nuclear force

- Electric and magnetic forces were united to get an electro magnetic force by Faraday and Maxwell.
- In 1979, Glashow Weinberg and Abdus Salam shared Nobel prize for the unification of electromagnetic and weak force (electroweak force).
- It is expected that strong nuclear force will unite with electro weak force resulting in grand unified electroweak force.

Force	Nature	Range	Carrier particles	Relative strength	Effect
Gravitational	Attractive	Long range infinite (obey inverse square law)	Gravitone (not yet discover)	$10^{-38}$	<ul style="list-style-type: none"> <li>➤ Binds the masses with each other such as stars and galaxies</li> <li>➤ Responsible for binding the satellite, atmosphere and sea with the earth</li> </ul>
Weak nuclear	Repulsive	Short range ( $\sim 10^{-17}m$ )	$W^+, W^-, Z^0$ (Bosons)	$10^{-13}$	<ul style="list-style-type: none"> <li>➤ Responsible for spontaneous breaking up of radioactive element.</li> <li>➤ Responsible for <math>\beta^+</math> and <math>\beta^-</math> decay</li> </ul>
Electro magnetic	Attractive or repulsive	Long range or infinite (obey inverse square law)	Photons	$10^{-2}$	<ul style="list-style-type: none"> <li>➤ Binds together atoms, molecules, crystal, trees</li> <li>➤ Responsible for various macroscopic forces such as friction, adhesion, cohesion etc.</li> </ul>
Strong nuclear	Attractive	Short range ( $\sim 10^{-15}m$ )	Gluons	1	<ul style="list-style-type: none"> <li>➤ Effective only within subnuclear distances.</li> <li>➤ Binds the neutrons and protons within the nucleus.</li> <li>➤ Responsible for binding planets with the sun.</li> </ul>

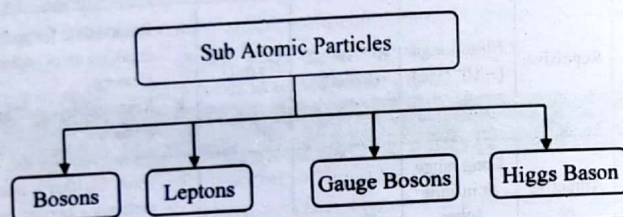
### Quarks:

- All photons quarks leptons are elementary particles.
- Hadrons are not elementary particles but are composed of quarks.
- According to quark theory by M. Gell Mann and G. Zweig the quarks are basic building block of mesons and baryons.
- It is proposed that there are six quarks

1. Up
2. Down
3. Strange
4. Charm
5. Bottom
6. Top

Six Types of Quarks		
Name	Symbol	Charge
Charm	$c$	$+\frac{2}{3}e$
Up	$u$	$+\frac{2}{3}e$
Top	$t$	$+\frac{2}{3}e$
Bottom	$b$	$-\frac{1}{3}e$
Down	$d$	$-\frac{1}{3}e$
Strange	$s$	$-\frac{1}{3}e$

Six Types of anti quarks		
Name	Symbol	Charge
Anti Charm	$\bar{c}$	$-\frac{2}{3}e$
Anti Up	$\bar{u}$	$-\frac{2}{3}e$
Anti Top	$\bar{t}$	$-\frac{2}{3}e$
Anti Bottom	$\bar{b}$	$+\frac{1}{3}e$
Anti Down	$\bar{d}$	$+\frac{1}{3}e$
Anti Strange	$\bar{s}$	$+\frac{1}{3}e$



Hadrons	<p><b>"Subatomic particles which experience strong nuclear force are called hadrons".</b>          Hadrons consist of quarks.  <b>Example:</b> mesons and baryons  <b>Mesons:</b> Subatomic particles having mass less than the proton are called mesons. Mesons consists of a pair of quark and anti quark.  <b>Baryons:</b> Subatomic particles having mass greater or equal to proton are called baryons. Baryons consists of three quarks          Proton and neutron are baryons</p>
Leptons	<p><b>"Subatomic particles which don't experience strong nuclear force are called leptons".</b>          don't consist of quarks  <b>Example:</b> electrons muons, tau and their associated neutrino</p>
Gauge Bosons	<p><b>"Gauge Bosons are exchange particles or carriers of basic forces of nature".</b>  <b>Example:</b> photons are carriers of electromagnetic force</p> <ul style="list-style-type: none"> <li>• Gluons are carriers for strong nuclear force.</li> <li>• <math>W^+, W^-, Z^0</math> Bosons are carrier of electro-weak force.</li> <li>• Gravitons are carrier of gravitational force</li> </ul>
Higgs Boson	<p>Higgs Bosons are discovered in July 2012, provides an explanation for how the other particles get mass by interacting with it.</p>

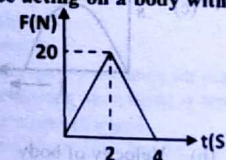
# PRACTICE BOOK

# UNIT 01 >>

# FORCE AND MOTION

## PRACTICE TEST NO. 1

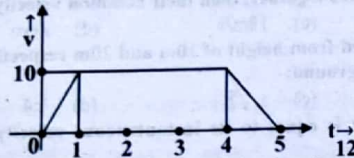
- If a body moves 3m towards north and 4m towards east then the ratio of distance to displacement covered by body is:  
(a) 1 (b)  $\frac{5}{7}$  (c)  $\frac{7}{5}$  (d) Zero
- Which of the following changes when particle is moving with uniform velocity?  
(a) Displacement (b) Speed (c) Acceleration (d) Velocity
- A truck of mass 2500kg moving with the velocity of 21m/s collides with a stationary car of mass 1000kg. After the collision the truck and car move together, then their common velocity will be:  
(a) 10.5m/s (b) 15m/s (c) 18m/s (d) Zero
- Two balls of masses of 2kg and 4kg are dropped from height of 10m and 20m respectively. Then what is the ratio between their velocities at the ground:  
(a) 1:1 (b) 1:2 (c)  $1:\sqrt{2}$  (d) 1:4
- When the average velocity of a moving body is equal to its instantaneous velocity then it is moving with:  
(a) Uniform velocity (b) Variable velocity  
(c) Uniform acceleration (d) Variable acceleration
- A force of 5 N acts on a body for 2 sec. What will be the rate of change in momentum?  
(a) 5 Ns (b) 10 N (c) 2.5 N (d) 5N
- Which of the following is an inertial frame of reference:  
(a) A car moving with uniform velocity (b) Earth revolving around the sun  
(c) A satellite revolving around the earth (d) All of these
- The variation of force acting on a body with time is shown. What is the change in momentum of body after 4 s?



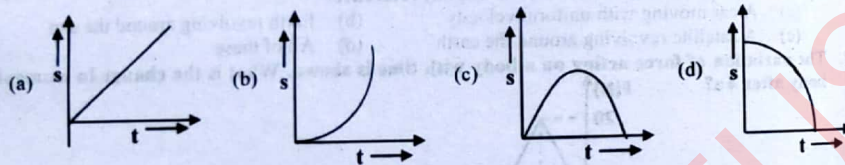
- (a) 10 Ns (b) 20 Ns (c) 40Ns (d) 80 Ns
- Two balls of masses  $m_1$  and  $m_2$  undergo an elastic collision. The transfer of energy is maximum if:  
(a)  $m_1 = m_2$  (b)  $m_1 > m_2$  (c)  $m_1 \gg m_2$  (d)  $m_1 < m_2$
- If a body is projected from 20m high tower in horizontal direction with velocity  $20\text{ms}^{-1}$  then its time of flight will be about  
(a) 1s (b) 2s (c) 3s (d) 10s
- If 1kg body is projected with initial velocity  $2\text{ms}^{-1}$  at an angle of  $30^\circ$  then time taken by the body to reach its maximum height is:  
(a) 0.1 s (b) 0.2s (c) 1s (d) 2sec
- Velocity of the projectile at maximum height is:  
(a)  $v_i$  (b)  $v_i \cos \theta$  (c)  $v_i \sin \theta$  (d) 0

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Ans:	c	a	b	c	a	d	a	c	a	b	b	b

13. The ratio of average speed to magnitude of average velocity is always:  
 (a) 1 (b)  $<1$  (c)  $\geq 1$  (d)  $\leq 1$
14. Which of the following must be zero for an internal frame of reference?  
 (a) Speed (b) Velocity (c) Acceleration (d) All of these
15. A body of mass 2kg falls under the action of gravity than the distance covered in 3s will be:  
 (a) 5m (b) 15m (c) 25m (d) 45m
16. If height of projectile is one fourth of its horizontal range then the angle of projection is:  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $90^\circ$
17. What is initial velocity of the ball projected at angle  $45^\circ$  if it covers a horizontal distance of 90m:  
 (a) 3m/s (b) 20m/s (c) 30m/s (d) 81m/s
18. A racing car accelerates uniformly through its gear changes with the following average speeds:  
 $20 \text{ ms}^{-1}$  for 2.0s,  $40 \text{ ms}^{-1}$  for 2.0s and  $60 \text{ ms}^{-1}$  for 6.0s. What is the overall average speed of the car?  
 (a)  $12 \text{ ms}^{-1}$  (b)  $48 \text{ ms}^{-1}$  (c)  $30 \text{ ms}^{-1}$  (d)  $50 \text{ ms}^{-1}$
19. A lift is going up. The variation in the speed of the lift is as given in the graph



20. What is the height to which the lift takes the passengers?  
 (a) 20m (b) 40m (c) 15m (d) 30m
21. A body is thrown in upward direction then which of the following represents the distance time graph of the body:



22. Force needed to stop an object depends upon  
 (a) Mass of body (b) Velocity of body  
 (c) Both mass and velocity (d) Inertia only
23. Example of impulsive force is  
 (a) Collision b/w snooker balls (b) A bat hitting the ball  
 (c) A boy kicking a football (d) All of these
24. Which of the following is not an example of projectile motion  
 (a) Motion of a ball hit by a player (b) A javelin thrown by athlete  
 (c) Flying of an aeroplane (d) Ballistic missile
25. Range of projectile is independent of  
 (a) Angle of projection (b) Velocity of projection  
 (c) Mass of the body (d) None of these

Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
Ans:	c	c	d	b	c	b	b	b	c	c	d	c	c

26. In a projectile motion velocity is  
 (a) Constant (b) Always perpendicular to force  
 (c) Perpendicular to force for half journey only  
 (d) Never perpendicular to force
27. Which of the following situation will hurt you more?  
 I. Kicking a football with time of impact  $\frac{1}{10}$  sec  
 II. Kicking a brick with time of impact  $\frac{1}{100}$  sec  
 III. Kicking a animal with time of impact  $\frac{1}{2}$  sec  
 (a) I (b) II (c) III (d) All will hurt equally
28. A moving massive body with velocity  $v_1$  collides with a stationary light body then the velocity of heavier body after the elastic collision is about  
 (a) Zero (b)  $v_1$  (c)  $-v_1$  (d)  $2v_1$
29. A body falling freely under the action of gravity is an example of  
 (a) Uniform acceleration (b) Variable velocity  
 (c) Uniform velocity (d) Dynamic equilibrium
30. Weight of 90kg man on the surface of moon will be ( $g_m = \frac{g_e}{6}$ )  
 (a) 150N (b) 300N (c) 450N (d) 900N
31. A stone is thrown upward from the top of a tower 59.4m high with velocity  $19.6 \text{ ms}^{-1}$ . How long is the stone in air.  
 (a) 2 sec (b) 4sec (c) 6sec (d) 7sec
32. Which of the following quantity changes when particle is moving with uniform acceleration in straight line  
 (a) Position vector (b) Speed (c) Velocity (d) All of three
33. Which of the following newton's law is an empirical law  
 (a) 1<sup>st</sup> law (b) 2<sup>nd</sup> law (c) 3<sup>rd</sup> law (d) All of these
34. Law of conservation of momentum holds for collisions in  
 (a) One dimension (b) Two dimension  
 (c) Three dimension (d) All of the these
35. If a moving ball undergoes an elastic on dimensional collision with a stationary ball of equal mass then which of the following statement is true.  
 (a) Velocities are interchanged (b) Momentum are interchanged  
 (c) Kinetic energies are interchanged (d) All of these
36. At which of the following angle a ball should be thrown so that it will remain in air for longer period of time  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $90^\circ$
37. The quality of moving body by virtue of which it exerts a force on the body that tries to stop it is called  
 (a) Inertia of the body (b) Force on the body  
 (c) Momentum of the body (d) All of these
38. N.s is unit of  
 (a) Work (b) Power  
 (c) Linear momentum (d) Angular momentum
39. If maximum range of projectile is 100m then its time of flight will be about:  
 (a) 4.4 sec (b) 9sec (c) 20sec (d) 20.9 sec

Sr.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.
Ans:	c	b	b	a	a	c	d	d	d	d	d	c	c	c

40. If a proton moving with velocity 'v' undergoes an elastic collision with stationary alpha particle then the velocity of alpha after the collision is about.
- (a)  $-\frac{3V}{5}$  (b)  $\frac{2V}{5}$  (c)  $-\frac{5V}{3}$  (d)  $\frac{5V}{2}$
41. A bomber drops a bomb when it is vertically above the target But it misses the target because of
- (a) Force of gravity (b) Inertia  
(c) Horizontal component of velocity (d) Both b and c
42. A body of mass 1kg moving with velocity 3m/s collides with a stationary ball of mass 5kg. Assuming elastic collision the velocity of bigger ball after the collision will be
- (a)  $1\text{ms}^{-1}$  (b)  $2\text{ms}^{-1}$  (c)  $-2\text{ms}^{-1}$  (d)  $1.5\text{ms}^{-1}$
43. A stone falls freely from a cliff. If it reaches the ground in four seconds then height of the cliff will be about
- (a) 20m (b) 45m (c) 60m (d) 80m
44. If velocity of a body is changing at constant rate then the resultant force acting on it
- (a) Is zero (b) Is increasing uniformly  
(c) Is constant but not zero (d) May or may not be zero
45. A particle of mass 'm' is projected from the ground with an initial speed  $u_0$  at an angle 'a' with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another particle of mass which was thrown vertically upward from the ground with the same initial speed  $u_0$ . The angle that the composite system makes with the horizontal immediately after the collision is
- (a)  $37^\circ$  (b)  $45^\circ - a$  (c)  $45^\circ + a$  (d)  $90^\circ$
46. When an object moves on a circular path and come back to its initial position, then:
- (a) Only its distance is zero  
(b) Only its displacement is zero  
(c) Neither distance nor displacement is zero  
(d) Both distance and displacement is zero
47. A straight moving bus takes a sharp right turn. What will happen to the passengers sitting inside the bus?
- (a) They will tilt rightwards (b) They will tilt leftwards  
(c) They will stay the way they were (d) They will start jumping
48. Acceleration of a an object is defined as the rate of change of:
- (a) Displacement (b) Time (c) Velocity (d) Distance
49. If a car starts from rest and reaches 20 m/s velocity in 10 m distance then acceleration is
- (a)  $20\text{ m/s}^2$  (b)  $10\text{ m/s}^2$  (c)  $5\text{ m/s}^2$  (d)  $2\text{ m/s}^2$
50. A motion with uniform negative acceleration can be represented on displacement time graph by
- (a) A horizontal line (b) A curve line with decreasing gradient  
(c) A straight line with constant gradient (d) A curve line with increasing gradient

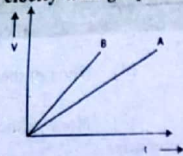
Sr.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	d	a	d	c	a	b	b	c	a	b

## PRACTICE TEST NO. 2

1. Projectile motion has \_\_\_\_\_ acceleration at each point of trajectory:
- (a) Variable (b) Constant (c) Zero (d) None of these
2. Projectile motion of object on earth is always
- (a) Linear (b) Parabolic (c) Circular (d) None of these
3. Average speed of a object after a completing a circle of 5m radius in 5 seconds:
- (a)  $2\pi$  (b)  $\pi$  (c) Zero (d)  $10\pi$
4. Average velocity is defined as
- (a) Displacement/time (b) Distance/time  
(c) Distance  $\times$  time (d) Displacement  $\times$  time
5. A ball is fired horizontally from the top of a cliff with sped of  $30\text{ms}^{-1}$ . What will be its speed after four seconds.
- (a)  $30\text{ms}^{-1}$  (b)  $40\text{ms}^{-1}$  (c)  $50\text{ms}^{-1}$  (d)  $60\text{ms}^{-1}$
6. Kinetic energy of a projectile is minimum at a point where velocity and acceleration are
- (a) Parallel (b) Anti-parallel (c) Perpendicular (d) zero
7. If a ball thrown with velocity v reaches to maximum height 'h'-then the ball having half mass and thrown with double velocity will reach maximum height
- (a) h (b) 2h (c) 4h (d) 16h
8. If a car is moving with increasing velocity then the angle between its velocity and acceleration is:
- (a)  $0^\circ$  (b)  $45^\circ$  (c)  $90^\circ$  (d)  $180^\circ$
9. If a lighter and heavier ball are moving with same momentum then
- (a) Lighter ball is moving faster (b) Heavier ball is moving faster  
(c) Both are moving with same speed (d) They can never have same momentum
10. A projectile is thrown at an angle  $\theta$ , during its motion the angle between velocity vector and acceleration:
- (a) Increase (b) Decrease (c) Remains same (d) Unpredictable
11. If a projectile is projected at an angle  $60^\circ$  then which of the following relation b/w range and height is true.
- (a)  $R > H$  (b)  $R < H$  (c)  $R = H$  (d)  $R = \sqrt{3}$
12. At the highest point of trajectory of a projectile which of the following quantities is zero:
- (a) Horizontal velocity (b) Total velocity  
(c) Vertical velocity (d) None of these
13. If the velocity of an object is increasing with time then acceleration is
- (a) Negative (b) Positive (c) Zero (d) None of these
14. An object moves 20 m in 5 sec. What is the gradient of the displacement-time graph?
- (a) 25 (b) 15 (c) 4 (d)  $1/4$
15. An object is moving at constant speed, which of the following is always true:
- (a) Distance is greater than displacement (b) Distance is lesser than displacement  
(c) Distance is equal to displacement (d) We cannot answer
16. The displacement has ....
- (a) Magnitude only (b) Direction only  
(c) Magnitude and direction (d) No unit
17. If momentum of a freely falling body is changing at a constant rate  $50\text{kgms}^{-2}$  then mass of the body will be
- (a) 5kg (b) 25kg (c) 50kg (d) 500kg

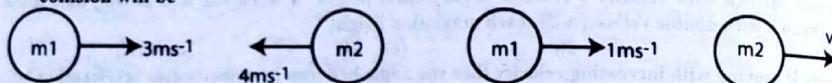
Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Ans:	b	b	a	a	c	c	c	a	a	b	a	c	b	c	d	c	a

18. Velocity-time graph for two bodies is shown in figure below



then which of the following statement is not true

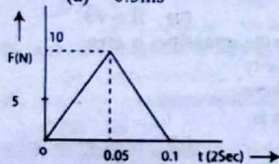
- (a) Distance covered by A is larger than B (b) Both are moving with constant acceleration  
(c) Acceleration of A is larger than B (d) None of these
19. If a ball is projected at angle  $45^\circ$  with initial kinetic energy  $E$ . Then its K.E at maximum height will be  
(a) Zero (b) 25% (c) 50% (d) 75%
20. Horizontal component of acceleration of a projectile is  
(a) Zero (b) Less than  $g$  (c) Greater than  $g$  (d) Equal to  $g$
21. If the elastic collision of two balls is shown in the figure below then velocity of  $m_2$  after the collision will be



Before Collision

After Collision

- (a)  $1\text{ms}^{-1}$  (b)  $2\text{ms}^{-1}$  (c)  $4\text{ms}^{-1}$  (d)  $8\text{ms}^{-1}$
22. A ball is projected at angle  $76^\circ$ . If it reaches maximum height 100m then its horizontal range will be  
(a) 50m (b) 100m (c) 200m (d) 400m
23. If variation of force with time on a 1kg football is shown in the figure below. Then the gain in velocity of the football is  
(a)  $0.5\text{ms}^{-1}$  (b)  $1\text{ms}^{-1}$  (c)  $2\text{ms}^{-1}$  (d)  $4\text{ms}^{-1}$



24. Which of the following is not an example of projectile motion.  
(a) A kicked football (b) A base ball shot  
(c) Bullet fired from gun (d) A gas filled balloon
25. A 2kg ball is projected at an angle  $60^\circ$  with horizontal what is its K.E at maximum height.  
(a) 50N (b) 75J (c) 150J (d) 200J
26. If a person throws a ball vertically upward and catches it 3 sec later. Neglecting air friction then the speed with which ball is thrown  
(a)  $12\text{ms}^{-1}$  (b)  $15\text{ms}^{-1}$  (c)  $18\text{ms}^{-1}$  (d)  $21\text{ms}^{-1}$
27. If two balls are dropped from height  $h$  and  $4h$  on the surface of earth then the ratio between time to reach the earth will be  
(a)  $1:\sqrt{2}$  (b)  $1:2$  (c)  $1:4$  (d)  $1:16$

Sr.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	c	c	a	d	b	a	d	b	b	b

28. In the above question acceleration produced in 1kg body is  
(a)  $5\text{ms}^{-2}$  (b)  $10\text{ms}^{-2}$  (c)  $20\text{ms}^{-2}$  (d)  $0.5\text{ms}^{-2}$

29. A 250m long train is moving with a uniform speed of  $72\text{kmh}^{-1}$ . The time taken by the train to cross a bridge of length 750m is  
(a) 50sec (b) 25 sec (c) 375 sec (d) 37.5 sec

30. A 1 kg ball moving with speed 10m/s collides with a wall and rebounds with same speed. If time of impact is  $\frac{1}{10}$  sec then force exerted on the wall is:  
(a) 100N (b) 200N (c) 1000N (d) 2000N

31. If a projectile reaches 100m height and 100m far from its initial point it strikes the ground then its angle of projection will be  
(a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $76^\circ$

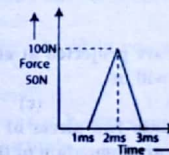
32. At maximum height velocity of projectile is equal to

- (a) Zero (b) Horizontal component of velocity  
(c) Vertical component of velocity (d) Initial velocity

33. The expression for height of projectile is

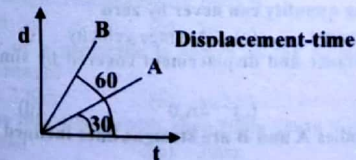
- (a)  $h = \frac{v_i^2 \sin^2 \theta}{g}$  (b)  $h = \frac{v_i^2 \sin 2\theta}{2g}$   
(c)  $h = \frac{v_i^2 \sin^2 \theta}{2g}$  (d)  $h = \frac{v_i \sin^2 \theta}{2g}$

34. If force-time graph of a body is shown in the figure below then change in momentum of body will be



- (a) 0.1N.s (b) 0.2N.s (c) 0.3N.s (d) 0.4N.s
35. A particle of mass  $m$  moving with a velocity strikes a wall and rebounds back. If the magnitude of the velocity is unchanged, the magnitude of force exerted on the wall by the particle during time of contact ( $t$ ) will be:  
(a) Zero (b)  $2mv/t$  (c)  $Mvt$  (d)  $mv/t$

36. The displacement-time graph of two bodies A and B are shown in fig. The ratio of  $V_A/V_B$  is:



- (a)  $\sqrt{3}$  (b)  $1/\sqrt{3}$  (c) 3 (d)  $1/3$
37. For projectile motion in the absence of air resistance:  
(a) Vertical speed is constant (b) K.E is constant  
(c) Horizontal acceleration is zero (d) Vertical acceleration is zero

Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
Ans:	b	a	b	d	b	c	a	b	d	c

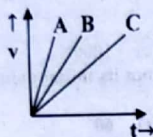
38. Acceleration of particle is not zero if:

- (a) Direction of velocity changes  
(c) Speed changes

- (b) Magnitude of velocity changes  
(d) All

39. If v-t graph for three moving bodies A, B, C is shown in the figure below then distance covered is large for

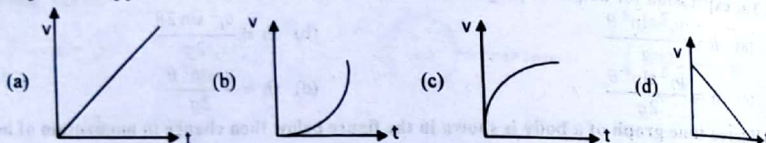
- (a) A (b) B (c) C (d) All have same



40. The resultant of two displacement 10m and 4m may be

- (a) 2m (b) 4m (c) 8m (d) 15m

41. An object is dropped from rest. Its v-t graph is



42. If two bodies of masses 1kg and 2kg are projected at angles of  $30^\circ$  and  $60^\circ$  respectively then the ratio between their maximum height will be:

- (a) 1:1 (b) 1:3 (c) 3:1 (d) 1:9

43. When a 4kg bomb at rest explodes into two pieces of masses 1kg and 3kg moving in opposite direction. Then the ratio between linear momentum of the pieces is:

- (a) 1:1 (b) 1:3 (c) 3:1 (d) 9:1

44. A force of 10N acts on stationary mass of 2kg for 5 s. then the gain in velocity is:

- (a)  $5 \text{ ms}^{-1}$  (b)  $10 \text{ ms}^{-1}$  (c)  $15 \text{ ms}^{-1}$  (d)  $25 \text{ ms}^{-1}$

45. Slope of velocity time graph gives the

- (a) Displacement (b) Speed (c) Acceleration (d) Velocity

46. If a body is falling freely then the distance covered by body in two second and 3<sup>rd</sup> second are

- (a) 20,30 (b) 20,25 (c) 20,45 (d) 25,45

47. For a moving body which of the following quantity can never be zero

- (a) Distance (b) Displacement (c) Average velocity (d) Acceleration

48. If A is amplitude of pendulum then distance and displacement covered by simple pendulum in one vibration are:

- (a) 0,0 (b)  $4A, 4A$  (c)  $4A, 0$  (d)  $0, 4A$

49. The displacement time graph for two bodies A and B are straight lines inclined at  $60^\circ$  and  $30^\circ$  to time axis. The ratio of their speeds is:

- (a) 3:1 (b)  $1:\sqrt{3}$  (c)  $\sqrt{3}:1$  (d) 1:3

50. A train has a speed of 60km/h for first one hour and 40km/h for the next half hour then its average speed is:

- (a) 53km/h (b) 80km/h (c) 120km/h (d) 180km/h

Sr.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	c	c	a	b	a	d	c	b	a	c	a	a

## PRACTICE TEST NO. 3

1. The ratio of displacement to distance covered by a body is always:

- (a) Less than one (b) Equal to one  
(c) Greater than one (d) Both a and b

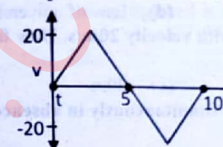
2. The ratio of distance to magnitude of displacement for a semi-circle of radius r is:

- (a)  $2\pi$  (b)  $\pi$  (c)  $\pi/2$  (d) 1

3. If body covers first half displacement with velocity  $v_1$  and second half displacement with velocity  $v_2$  then its average velocity is

- (a)  $\frac{v_1 + v_2}{2}$  (b)  $\frac{2v_1 v_2}{v_1 + v_2}$  (c)  $\frac{v_1 + v_2}{2t}$  (d)  $\frac{v_1 v_2}{v_1 + v_2}$

4. Find the total distance and displacement covered from the following v-t graph:



- (a) 0,0 (b) 100,100 (c) 200,200 (d) 100,0

5. Time rate of change of momentum of a body is equal to:

- (a) Acceleration (b) Force (c) Torque (d) Power

6. Two blocks of masses 1kg and 3kg placed in contact are acted upon by a force of 40N. the acceleration of 1kg mass will be:

- (a)  $4 \text{ ms}^{-2}$  (b)  $10 \text{ ms}^{-2}$  (c)  $30 \text{ ms}^{-2}$  (d)  $50 \text{ ms}^{-2}$

7. A person standing in a boat throws a heavy stone in forward direction the boat moves in backward direction according to Newton's:

- (a) 1<sup>st</sup> Law (b) 2<sup>nd</sup> Law (c) 3<sup>rd</sup> Law (d) None

8. If the velocity time graph of a body is parallel to time axis then body is moving with

- (a) Uniform velocity (b) Uniform acceleration  
(c) Non uniform acceleration (d) Both a and b

9. In case of elastic collision which of the quantity is conserved:

- (a) Kinetic energy (b) Momentum (c) Total energy (d) All of these

10. If 1kg body is projected at an angle  $30^\circ$  with the horizontal, with an initial velocity  $20 \text{ ms}^{-1}$ . Then maximum height reached by the body is:

- (a) 1m (b) 5m (c) 10m (d) 0.5m

11. Trajectory of a projectile is shown in the figure below. Then what is its time of flight and horizontal range?

- (a) 4s, 120m (b) 8s, 220m (c) 8s, 320m (d) 16s, 420m

12. An airplane flies 400m north, then 200m South then its resultant displacement is:

- (a) 200m (b) 300m (c) 500m (d) 700m

13. If two bodies of masses 2kg and 4kg are subjected to same force then the ratio between the acceleration produced in the bodies is:

- (a) 1:2 (b) 2:1 (c) 1:4 (d) 1:1

14. If slope of velocity time graph is not constant at different points then body is moving with:

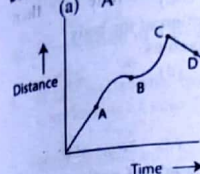
- (a) Constant acceleration (b) Average acceleration  
(c) Variable acceleration (d) Uniform velocity

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	d	c	b	b	b	c	d	d	d	b	c	a	b	c

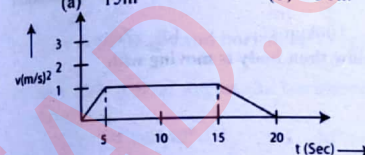
15. If displacement time graph of a body is a straight line inclined at  $30^\circ$  with time axis then acceleration will be:  
 (a) 1 (b)  $\sqrt{3}$  (c)  $\frac{1}{\sqrt{3}}$  (d) Zero
16. At which point the velocity and acceleration of projectile are perpendicular:  
 (a) Point of projection (b) Maximum height  
 (c) Point where it hit the ground (d) None
17. If a 2kg body thrown with velocity 10m/s reaches its maximum height in 5s then its time of flight is:  
 (a) 5s (b) 10s (c) 15s (d) 25s
18. Newton first law of motion is also known as:  
 (a) Law of conservation of momentum (b) Law of inertia  
 (c) Law of electromagnetism (d) Law of universal gravity
19. If a bomb is projected at an angle of  $45^\circ$  with velocity 20m/s. How far from the starting point will it strike?  
 (a) 20m (b) 30m (c) 40m (d) 50m
20. When an apple and leaf falls from a tower simultaneously in absence of air friction then  
 (a) Both have same acceleration  
 (b) Both reaches the ground with same velocity  
 (c) Both reaches the ground in same time  
 (d) All of these
21. A 2.5kg stone is released from rest and falls towards earth, after 4s the magnitude of its momentum is:  
 (a) 98kgms<sup>-1</sup> (b) 78kgms<sup>-1</sup> (c) 39kgms<sup>-1</sup> (d) 59kgms<sup>-1</sup>
22. The average force necessary to stop a body, having a momentum of 25N s, in 0.05s is:  
 (a) 5N (b) 500N (c) 50N (d) 5000N
23. SI unit of momentum is  
 (a) N.S (b) Kgms<sup>-1</sup> (c) Both a and b (d) J.s
24. Range of projectile is maximum at  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $76^\circ$
25. The change in momentum of a body is equal to  
 (a) Force (b) Power  
 (c) Pressure (d) Impulse
26. Wearing a helmet prevents from injury because  
 (a) Increase the force on head (b) It increase the time of impact  
 (c) It decrease the time of impact (d) Both a and b
27. A body is projected at on angle  $30^\circ$  with x-axis then the angle with which it strikes the ground at same level will be  
 (a)  $30^\circ$  (b)  $-30^\circ$  (c)  $90^\circ$  (d)  $180^\circ$
28. If a ball is projected with velocity  $u$  then its maximum range will be  
 (a)  $\frac{2u}{g}$  (b)  $\frac{u^2}{2g}$  (c)  $\frac{u^2}{g}$  (d)  $\frac{u}{2g}$
29. If a 100 dynes force acts on a 5kg body for two seconds then impulse on the body is  
 (a)  $2 \times 10^{-3}$  kgms<sup>-1</sup> (b)  $4 \times 10^{-3}$  kgms<sup>-1</sup> (c)  $10 \times 10^{-3}$  kgms<sup>-1</sup> (d) Zero
30. Two balls are projected at angles  $30^\circ$  and  $45^\circ$  with same initial speed. The ratio of their maximum height will be  
 (a)  $1:\sqrt{2}$  (b)  $\sqrt{2}:1$  (c)  $1:2$  (d)  $2:1$

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Ans:	d	b	b	b	c	d	a	b	c	b	d	b	b	c	a	c

31. Distance - time graph of body is shown in fig. below then at which point the velocity is minimum  
 (a) A (b) B (c) C (d) D



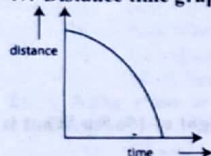
32. The acceleration of projectile is maximum at  
 (a) Point of projection (b) Maximum height  
 (c) Just before hitting the ground (d) Same at all point
33. If a variation in speed of a lift moving upward is shown in figure below then the height reached by lift will be  
 (a) 15m (b) 30m (c) 45m (d) 60m



34. A helicopter ascending upward with velocity  $19.6\text{ms}^{-1}$  drop a stone at height of 156.8m What is time taken by stone to reach the ground.  
 (a) 2 sec (b) 4 sec (c) 6 sec (d) 8sec
35. Centrifuge works on the principle of Newton's  
 (a) 1<sup>st</sup> law of motion (b) 2<sup>nd</sup> law of motion  
 (c) 3<sup>rd</sup> law of motion (d) Law of gravitation
36. Displacement is a  
 (a) Tensor (b) Vector (c) Scalar (d) None of these
37. Which of the following motion is a type of 2D motion?  
 (a) Circular (b) Pendulum motion (c) Projectile motion (d) All of these
38. People sitting in a moving bus experience a jerk when the bus stops. This is due to  
 (a) Inertia of motion (b) Inertia of rest  
 (c) Inertia of turning (d) Inertia of acceleration
39. If a squash ball comes back to its starting point after bouncing off the wall several times, then:  
 (a) Its total displacement is zero but its average velocity is non-zero  
 (b) Its total displacement is non-zero but its average velocity is zero  
 (c) Both its total displacement and its average velocity is non-zero  
 (d) Its total displacement is zero and so also is its average velocity
40. Projectile when launched at  $90^\circ$  degree with respect to horizontal then its trajectory is  
 (a) Parabolic (b) Hyperbolic trajectory  
 (c) Periodic (d) Linear

Sr.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	b	d	a	d	a	b	d	a	d	d

41. Area under velocity time graph gives the  
 (a) Distance covered by body (b) Force acting on a body  
 (c) Acceleration of a body (d) Change in momentum of the body
42. Force required to accelerate a particle from rest to speed  $v$  in a time  $t$  is given as  
 (a)  $\frac{mv}{t}$  (b)  $\frac{mv}{2t}$  (c)  $\frac{mv^2}{t}$  (d)  $\frac{mv^2}{2t}$
43. Rocket propulsion is an example of Newton's  
 (a) 1<sup>st</sup> law (b) 2<sup>nd</sup> law (c) 3<sup>rd</sup> law (d) None of these
44. If the relation between range and height of a projectile is  $R = 4\sqrt{3}$  then angle of projection will be  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $80^\circ$
45. A shell is fired at an angle of  $30^\circ$  with the horizontal with initial velocity  $100\text{ms}^{-1}$  it will hit the ground after about  
 (a) 5 sec (b) 10sec (c) 15sec (d) 20 sec
46. If a body of mass 10kg is falling under the action of gravity then its rate of change of momentum is about  
 (a)  $10\text{kgms}^{-2}$  (b)  $50\text{kgms}^{-2}$  (c)  $100\text{kgms}^{-2}$  (d) Zero
47. Distance time graph of a body is shown in the figure below then body is moving with



- (a) Uniform speed (b) Uniform velocity (c) Uniform acceleration (d) None of these
48. A particle is moving with uniform velocity then no force is required to  
 (a) Change its speed (b) Change its direction  
 (c) Stop its motion (d) Continue its motion with same velocity
49. A horizontal line in displacement-time graph represents:  
 (a) Uniform acceleration motion (b) motion with constant velocity  
 (c) Motion with constant speed (d) Body at rest
50. Acceleration is always \_\_\_\_\_ for a freely falling body  
 (a) Constant (b) Variable (c) Zero (d) Negative

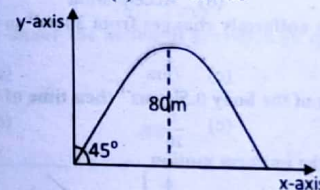
Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	a	c	a	b	c	c	d	d	a

## PRACTICE TEST NO. 4

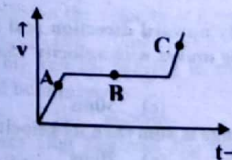
1. The shortest distance between two points having the coordinates (2,3) and (5,7) is  
 (a) 1 (b) 3 (c) 5 (d) 7
2. A car travels for a certain distance. Its speed during the first half distance is  $10\text{ms}^{-1}$  and during the second half distance is  $20\text{ms}^{-1}$ . Average speed is about:  
 (a)  $13\text{ms}^{-1}$  (b)  $15\text{m/s}$  (c)  $30\text{ms}^{-1}$  (d)  $10\text{ms}^{-1}$
3. If a car is moving in a circular path with uniform speed then its velocity and acceleration are .... to each other:  
 (a) Parallel (b) Perpendicular (c) Anti-parallel (d) None of these

Sr.	1	2	3
Ans:	c	a	b

4. A retarding force of 200 N is applied on a body of mass 100 kg moving with a speed of  $20\text{ms}^{-1}$ . How long does the body take to stop?  
 (a) 1 s (b) 2 s (c) 10 s (d) 20 s
5. Momentum of a body and its kinetic energy are numerically equal if body moving with velocity:  
 (a)  $1\text{ms}^{-1}$  (b)  $2\text{ms}^{-1}$  (c)  $5\text{ms}^{-1}$  (d)  $10\text{ms}^{-1}$
6. If the horizontal range and time of flight of a body are 40m and 10s respectively then horizontal component of velocity will be:  
 (a)  $2\text{ms}^{-1}$  (b)  $4\text{ms}^{-1}$  (c)  $5\text{ms}^{-1}$  (d)  $8\text{ms}^{-1}$
7. Acceleration can be found from:  
 (a) Area under v-t graph (b) Slope of v-t graph  
 (c) Area under d-t graph (d) Slope of d-t graph
8. If 2kg ball moving with velocity  $10\text{ms}^{-1}$  relative to 1kg ball before the collision. Then after the elastic collision relative velocity of 2kg ball will be:  
 (a)  $10\text{ms}^{-1}$  (b)  $-10\text{ms}^{-1}$  (c)  $20\text{ms}^{-1}$  (d)  $5\text{ms}^{-1}$
9. If a body is projected with initial velocity  $20\text{m/s}$  at angle of  $\theta$  then height will be maximum when  $\theta$  is:  
 (a)  $20^\circ$  (b)  $0^\circ$  (c)  $60^\circ$  (d)  $80^\circ$
10. Maximum height and horizontal ranges are equal if body is projected at an angle of  
 (a)  $36^\circ$  (b)  $46^\circ$  (c)  $76^\circ$  (d)  $90^\circ$
11. At which pair of angles the horizontal ranges for a projectile thrown with initial velocity  $v$  are equal:  
 (a)  $30^\circ$  and  $40^\circ$  (b)  $40^\circ$  and  $50^\circ$  (c)  $50^\circ$  and  $60^\circ$  (d)  $60^\circ$  and  $70^\circ$



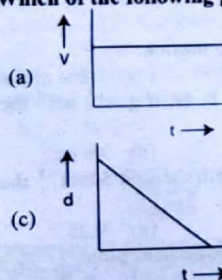
12. Which of the following quantity change its direction during projectile motion:  
 (a) Acceleration (b) Velocity (c) Force (d) None of these
13. An arrow is shot into air. Its range is 200m and its time of flight is 5s. if  $g = 10\text{ms}^{-2}$  then the horizontal component of velocity of the arrow is:  
 (a)  $12.5\text{ms}^{-1}$  (b)  $31.25\text{ms}^{-1}$  (c)  $25\text{ms}^{-1}$  (d)  $40\text{ms}^{-1}$
14. If two bodies having same momentum are moving with velocities  $30\text{ms}^{-1}$  and  $50\text{ms}^{-1}$  then the ratio b/w their masses will be  
 (a) 1:1 (b) 3:5 (c) 5:3 (d) 9:25
15. If v-t graph for a body is shown the fig below then acceleration is maximum at point



- (a) 0 (b) A (c) B (d) C

Sr.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Ans:	c	b	b	b	b	d	c	b	b	d	c	d

16. If two bodies are projected with same speed at angle of  $30^\circ$  and  $60^\circ$  then the ratio between their time of flight will be:  
 (a) 1:1 (b)  $1:\sqrt{3}$  (c)  $\sqrt{3}:1$  (d) 1:3
17. If velocity of projectile at maximum height is 50% of its initial velocity then the angle of projection is:  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $75^\circ$
18. When we jump out of a boat standing in water, it moves:  
 (a) Backward (b) Sideways (c) Forward (d) None of these
19. A moving body will have impulse if it is moving with  
 (a) Variable velocity (b) Constant acceleration  
 (c) Variable acceleration (d) All of these
20. If two bodies of unequal masses collide with each other then which of the following statement is not true.  
 (a) Both are subjected to same force (b) Both are subjected to same impulse  
 (c) Momentum of both balls changes equally (d) None of these
21. A 1200kg car has its velocity reduced from  $20\text{ms}^{-1}$  to  $15\text{ms}^{-1}$  in 3 sec the retarding force on the car is  
 (a) 20N (b) 200N (c) 2000N (d) 20000N
22. The time rate of change of momentum of a body falling freely under the action of gravity is equal to its.  
 (a) Kinetic energy (b) Impulse  
 (c) Weight (d) Acceleration
23. The velocity of a car which is decelerating uniformly changes from  $30\text{ms}^{-1}$  to  $15\text{ms}^{-1}$  in 75m. After what further distance will it come to rest?  
 (a) 25 m (b) 50m (c) 75m (d) 100m
24. If 10N force causes a change in momentum of the body  $0.5\text{kgms}^{-1}$  then time of impact of force is  
 (a) 5 sec (b)  $\frac{1}{10}\text{sec}$  (c)  $\frac{1}{20}\text{sec}$  (d)  $\frac{1}{50}\text{sec}$
25. Which of the following graph represents the uniform motion



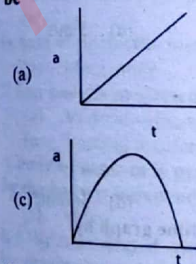
(d) All of these

26. A bomb of mass 200g is thrown in vertically upward direction and it explodes at the top of its path into two pieces. If one piece of mass 50g moves with velocity  $15\text{m/s}$  then velocity of 2<sup>nd</sup> piece will be  
 (a)  $5\text{ms}^{-1}$  (b)  $10\text{m/s}$  (c)  $30\text{ms}^{-1}$  (d)  $45\text{ms}^{-1}$

27. A ball is projected at  $45^\circ$ . If its horizontal range is 40m then its velocity of projection will be  
 (a)  $5\text{ms}^{-1}$  (b)  $10\text{ms}^{-1}$  (c)  $20\text{ms}^{-1}$  (d)  $40\text{ms}^{-1}$

Sr.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	b	c	a	d	d	c	c	a	c	d	a	c

28. Force required to accelerate a 2kg body from velocity  $5\text{ms}^{-1}$  to  $10\text{ms}^{-1}$  in 20 sec is  
 (a) 0.1 N (b) 0.5N (c) 1N (d) 1.5N
29. If force required to stop a car is F then force required to stop another car in same time, moving with double momentum will be:  
 (a) F (b) 2F (c) F/2 (d) 4F
30. If X is distance covered by a freely falling body in two seconds and Y is distance covered in 3<sup>rd</sup> second then the relation between X and Y will be  
 (a)  $X = 5Y$  (b)  $X = \frac{Y}{5}$  (c)  $X = Y - 5$  (d)  $X = Y + 5$
31. Force required to accelerate an object of mass 2kg from rest to a velocity  $10\text{ms}^{-1}$  in 5 sec is  
 (a) 2N (b) 4N (c) 8N (d) 10N
32. Mass  $M_1$  has a velocity of 0 m/s and mass  $M_2$  has a velocity of 5 m/s. Mass  $M_1 > M_2$ . Which one has larger inertia?  
 (a)  $M_2$  (b)  $M_1$   
 (c) Both  $M_1$  and  $M_2$  (d) Not enough information
33. Two blocks of masses 1kg and 4kg are placed in contact and are acted upon by a force of 50N then the force on 4kg body is  
 (a) 10N (b) 40 N (c) 50N (d) 200 N
34. Rate of change in displacement is known as:  
 (a) Speed (b) Velocity (c) Acceleration (d) Momentum
35. If a projectile is launched with  $3\text{m/s}$  velocity at  $60^\circ$  degree angle then at highest point its horizontal velocity is  
 (a)  $3\text{m/s}$  (b)  $2\text{m/s}$  (c)  $1.5\text{m/s}$  (d)  $1.8\text{m/s}$
36. If a body falls under the action of gravity then the graph between its acceleration and time will be



37. Velocity of an object changes from 20 m/s to 50 m/s in 5 sec. What is the acceleration of the object?

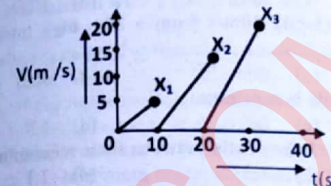
- (a) 6 m/s (b)  $6\text{m/s}^2$  (c) 10 m/s (d)  $10\text{m/s}^2$
38. If a heavy ball of 5kg moving with velocity  $10\text{ms}^{-1}$  collides with a stationary ball of mass 10g. Considering elastic collision the velocity of lighter ball after the collision will be  
 (a) Zero (b)  $10\text{ms}^{-1}$  (c)  $-10\text{ms}^{-1}$  (d)  $20\text{ms}^{-1}$
39. Two balls of masses  $m_1$  and  $m_2$  moving in same straight line undergo an elastic collision then transfer of energy will be minimum  
 (a)  $m_1 = m_2$  (b)  $m_1 \gg m_2$  (c)  $m_1 \ll m_2$  (d) Both a and c
40. If three balls of masses 1kg, 2kg and 3kg are moving with velocities  $20\text{ms}^{-1}$ ,  $15\text{ms}^{-1}$  and  $5\text{ms}^{-1}$  respectively then it will be more harder to stop  
 (a) 1 kg ball (b) 2kg ball (c) 3kg ball (d) None of these

Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	b	b	c	b	b	b	b	c	b	b	d	d	b

41. If a shell explodes in air and its fragments fly off in different directions. Then total momentum of fragments is  
 (a) Zero (b) Less than initial momentum  
 (c) Greater than initial momentum (d) Equal to initial momentum
42. If a 2kg ball moving with velocity  $2\text{ms}^{-1}$  strikes the wall and rebounds back with same velocity then impulse acting on the ball will be  
 (a) Zero (b)  $2\text{ N.s}$  (c)  $4\text{ N.s}$  (d)  $8\text{ N.s}$
43. If a ball projected vertically upward reaches the ground in 10 sec with velocity  $49\text{ms}^{-1}$  then acceleration of the ball is.  
 (a)  $4.9\text{ms}^{-2}$  (b)  $9.8\text{ms}^{-2}$  (c)  $-4.9\text{ms}^{-2}$  (d)  $-9.8\text{ms}^{-2}$
44. Consider a car is travelling for one hour. In which of the following cases the average velocity is zero?  
 (a) Car travels 20 km due east  
 (b) Car travels 60 km due east, then turns around and travels 40 km due west  
 (c) Car travels 70 km due east  
 (d) Car travels 30 km due west, then turns around and travels 30 km due east
45. Decrease in velocity per unit time is called  
 (a) Acceleration (b) Retardation  
 (c) Positivity acceleration (d) Uniform acceleration
46. A body falls freely under the action of gravity. How much distance it falls during an interval between 2<sup>nd</sup> and 3<sup>rd</sup> second of its motion.  
 (a) 5m (b) 10m (c) 25m (d) 45m
47. When a particle is launched at angle of 90 degree with respect to horizontal then vertical acceleration is  
 (a)  $-9.8\text{ m/s}^2$  (b)  $9.8\text{ m/s}^2$  (c) 0 (d)  $5\text{ m/s}^2$
48. When an object moves in a straight line then  
 (a) Its displacement is equal to distance  
 (b) Its displacement is greater than distance  
 (c) Its displacement is less than distance  
 (d) We cannot measure displacement
49. Acceleration of a moving car when brakes are applied is  
 (a) Negative (b) Zero (c) Positive (d) Infinite
50. A motion with constant velocity can be represented on displacement time graph by:  
 (a) A horizontal line  
 (b) A curve line with decreasing gradient  
 (c) A straight line with constant gradient  
 (d) A curve line with increasing gradient

Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	d	d	d	b	b	a	a	a	c

1. The  $X_1$ ,  $X_2$  and  $X_3$  are distance travelled by the three different particles whose velocity-time graph are shown below then



- (a)  $x_1 > x_2 > x_3$  (b)  $x_1 = x_2 > x_3$  (c)  $x_1 = x_2 = x_3$  (d)  $x_1 < x_2 < x_3$
2. An athlete completes one round of a circular track of radius 10m in 40 seconds what will be its average velocity  
 (a)  $0.5\text{ ms}^{-1}$  (b)  $\pi/4\text{ ms}^{-1}$  (c)  $\pi/2\text{ms}^{-1}$  (d) 0
3. If a body is thrown vertically upward, it moves upward with acceleration 'x' and moves downward with acceleration 'y' then the angle between 'x' and 'y' is:  
 (a)  $0^\circ$  (b)  $45^\circ$  (c)  $90^\circ$  (d)  $180^\circ$
4. How far does a car travel in 6 s if its initial velocity is 2 m/s and its acceleration is  $2\text{ m/s}^2$  in the forward direction:  
 (a) 12 m (b) 14 m (c) 24 m (d) 48 m
5. The ratio of unit of impulse to unit of momentum is:  
 (a) kg (b) m (c)  $\text{s}^{-1}$  (d) 1
6. In case of projectile motion which of the following quantity is conserved (remain constant):  
 (a) Momentum (b) Velocity (c) Acceleration (d) Kinetic energy
7. When body is projected at an angle of  $30^\circ$  then which of the following always remains zero:  
 (a) Vertical velocity (b) Horizontal velocity  
 (c) Vertical acceleration (d) Horizontal acceleration
8. A body of mass m is projected at an angle  $\theta$  with initial velocity v then maximum height reached by the body is independent of:  
 (a) Mass (b) Angle of projection (c) Initial velocity (d) gravity
9. If body is projected with initial velocity  $10\text{ms}^{-1}$  it reaches to maximum height of 40m. What will be maximum height if body is projected with initial velocity of  $20\text{ms}^{-1}$  at the same angle of projection:  
 (a) 20m (b) 40m (c) 80m (d) 160m
10. At which angle of projection the horizontal range will be maximum  
 (a)  $30^\circ$  (b)  $40^\circ$  (c)  $60^\circ$  (d)  $90^\circ$
11. If the ratio between time of flight of two projectiles is 1:2 then the ratio between their maximum height is:  
 (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1
12. Quantitative measure of inertia of the body is its:  
 (a) Mass (b) Volume (c) Energy (d) Momentum

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Ans:	d	c	d	d	d	c	d	a	d	b	c	a

13. A force of 2N acts on a 2kg body for 5s then the change in momentum of the body is:  
 (a) 5kgm/s (b) 2kgm/s (c) 10kgm/s (d) Zero
14. An engine of the car produces the acceleration of  $4\text{m/s}^2$  in the car. If this car pulls another car of same mass then acceleration will be:  
 (a)  $8\text{m/s}^2$  (b)  $4\text{m/s}^2$  (c)  $2\text{m/s}^2$  (d)  $1/2\text{m/s}^2$
15. A body is thrown in horizontal direction with velocity 20m/s from a 20m high tower then its horizontal range will be:  
 (a) 10m (b) 20m (c) 40m (d) 50m
16. At which of the following angle the range of projectile is maximum:  
 (a)  $20^\circ$  (b)  $40^\circ$  (c)  $60^\circ$  (d)  $80^\circ$
17. If the ratio between time of flight of two bodies is 1:3 then ratio between their maximum height:  
 (a) 1:9 (b) 9:1 (c) 1:3 (d) 3:1
18. A force  $\vec{F} = 8\hat{i} - 6\hat{j} - 10\hat{k}$  N produces an acceleration of  $1\text{ms}^{-2}$  in a body. The mass of the body is:  
 (a) 10kg (b) 14kg (c) 20kg (d) 200kg
19. A graph is drawn with force along Y-axis and time along X-axis. The area under the graph represents:  
 (a) Momentum (b) Momentum of force  
 (c) Work (d) Impulse of force
20. A ball is thrown vertically upward with a velocity of  $98\text{ms}^{-1}$ . If it takes 10 s to reach the highest point, then the acceleration of the ball is:  
 (a)  $9.8\text{ms}^{-2}$  (b)  $980\text{ms}^{-2}$  (c)  $98\text{ms}^{-2}$  (d)  $-9.8\text{ms}^{-2}$
21. A projectile is thrown at an angle  $\theta$ , during its motion the angle between velocity vector and acceleration:  
 (a) Increase (b) Decrease (c) Remains same (d) Unpredictable
22. A force of 6N acts on a mass of 1kg which acquire a velocity  $30\text{ms}^{-1}$ . The time for which the force acts is:  
 (a) 8s (b) 5s (c) 6s (d) 2s
23. Momentum of a 1000kg car if it covers a distance 20m in 100sec will be  
 (a) 20Ns (b) 200Ns (c) 2000Ns (d) 20,000Ns
24. If a 1000kg car and 2500kg truck are moving with velocities 15m/s and 5m/s respectively. Then force needed to stop them in same is larger for  
 (a) Truck (b) Car  
 (c) Same for car and truck (d) Can not be determined
25. If two bodies of unequal masses are moving with same momentum then which of the following relation is correct.  
 (a)  $m_1v_1 = m_2v_2$  (b)  $m_1v_2 = m_2v_1$  (c)  $v_1 = v_2$  (d)  $\frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$
26. Impulse can be calculated from area under  
 (a) Velocity – time graph (b) Force – displacement graph  
 (c) Force – time graph (d) Displacement – time graph
27. If 'J' is impulse acting on a body then  
 (a)  $J = v_f - v_i$  (b)  $J = m(v_f - v_i)$  (c)  $J = ft$  (d)  $J = ma$

Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	c	c	b	a	b	d	d	b	b	b	b	b	a	c	B

28. If A 10kg mass travelling with velocity  $2\text{ms}^{-1}$  collides elastically with a 2kg mass travelling with velocity  $4\text{ms}^{-1}$  in opposite direction. The final velocities of both object after the collision are  
 (a)  $0\text{ms}^{-1}$ ,  $6\text{ms}^{-1}$  (b)  $4\text{ms}^{-1}$ ,  $6\text{ms}^{-1}$   
 (c)  $2\text{ms}^{-1}$ ,  $6\text{ms}^{-1}$  (d)  $8\text{ms}^{-1}$ ,  $6\text{ms}^{-1}$
29. If a ball is thrown with a speed of  $20\text{ms}^{-1}$  at an angle of  $30^\circ$  then its time of flight will be about  
 (a) 1 sec (b) 1.2 sec (c) 2 sec (d) 2.2 sec
30. If maximum range of projectile is 160m then its maximum height will be  
 (a) 20m (b) 40m (c) 60m (d) 80m
31. Which of the following statement is not true about projectile motion projected at an angle ' $\theta$ '.  
 (a) Horizontal velocity is constant (b) Vertical acceleration is constant  
 (c) Acceleration is always perpendicular to velocity  
 (d) K.E at maximum height is not zero
32. If a body is projected at an angle of  $60^\circ$ . Then its P.E at highest point of its trajectory will be..  
 (a) 25% (b) 50% (c) 75% (d) 100%
33. Which of following is not true in case of inelastic collision  
 (a) Total momentum is conserved (b) Total energy is conserved  
 (c) Total K.E is conserved (d) None of these
34. If two balls are projected at angles  $30^\circ$  and  $60^\circ$  with same speed then the ratio b/w their time of flight will be  
 (a) 1:1 (b)  $1:\sqrt{3}$  (c)  $\sqrt{3}:1$  (d) 1:3
35. A force of 100N acts on a 5kg body for 0.25 sec then rate of change of momentum and change in momentum of the body will be  
 (a) 100, 25 (b) 100, 100 (c) 200, 25 (d) 200, 100
36. A body of mass 2kg falls from a height 125m under action of gravity. The time taken by ball to reach the ground is:  
 (a) 2.5 sec (b) 5 sec (c) 7.5 sec (d) 10 sec
37. A body accelerates uniformly when net force acting on it  
 (a) Increase uniformly (b) Decrease uniformly (c) Zero (d) Constant but not zero
38. A fighter jet flying horizontally at a height of 2km above the ground releases a bomb when target is 800m ahead of it. In order to hit the target what should be the speed of jet.  
 (a)  $20\text{ms}^{-1}$  (b)  $40\text{ms}^{-1}$  (c)  $60\text{ms}^{-1}$  (d)  $80\text{ms}^{-1}$
39. A stationary nucleus of mass no. 'A' decays by emitting a proton with speed v and residual nucleus moves with speed u in opposite direction then speed of proton will be  
 (a)  $(A-1)u$  (b)  $\frac{u}{A-1}$  (c)  $(A+1)u$  (d)  $\frac{u}{A+1}$
40. Which of the following is a motion with constant acceleration  
 (a) Projectile motion (b) An object falling freely  
 (c) An object thrown in horizontal direction (d) All of these
41. If a projectile has maximum range 120m then maximum height attained by it will be  
 (a) 30 m (b) 60m (c) 100m (d) 120m
42. If four projectiles are projected with same speed at different angles then range will be longest for projectile whose angle is  
 (a)  $20^\circ$  (b)  $50^\circ$  (c)  $60^\circ$  (d)  $80^\circ$
43. A ball is thrown with velocity  $10\text{ms}^{-1}$ . If at maximum height its velocity is  $7\text{ms}^{-1}$  then angle of projection is about  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $76^\circ$

Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	b	c	b	c	c	c	b	a	b	d	d	d	d	a	b	b

44. If an electron moving with velocity 'v' undergoes an elastic collision with stationary alpha particle velocity of electron after the collision will be about  
(a) V (b) -V (c) 2V (d) Zero
45. The horizontal range of the shell fired at angle  $45^\circ$  with velocity  $200\text{ms}^{-1}$  is  
(a) 2km (b) 3km (c) 4km (d) 5km
46. If a 4kg dog jumps out with velocity  $2\text{ms}^{-1}$  from a stationary 40kg boat then the boat will move backward with velocity  
(a)  $0.1\text{ms}^{-1}$  (b)  $0.2\text{ms}^{-1}$  (c)  $0.4\text{ms}^{-1}$  (d)  $0.9\text{ms}^{-1}$
47. A particle of mass moving eastward with a speed v collides with another particle of same mass moving northward with same speed 'v'. the two particles will move with velocity.  
(a)  $\sqrt{2}v$  north-east (b)  $\sqrt{2}v$  north-west (c)  $\frac{v}{\sqrt{2}}$  north-east (d)  $\frac{v}{\sqrt{2}}$  north-west
48. Which of the following is not true for a moving body  
(a) Displacement may be zero (b) Velocity may be zero  
(c) Acceleration may be zero (d) Displacement may be greater than distance
49. A stone is projected vertically upward with velocity  $10\text{ms}^{-1}$  near the edge of a cliff. After how long the stone hit the bottom of the cliff 15m below the edge?  
(a) 2sec (b) 3sec (c) 4sec (d) 5sec
50. If a 1000kg is brought to rest by retarding force of  $10^3\text{N}$  in 20 seconds then initial velocity of the car will be.  
(a)  $10\text{ms}^{-1}$  (b)  $20\text{ms}^{-1}$  (c)  $200\text{ms}^{-1}$  (d)  $2 \times 10^{-3}\text{m/s}$
51. Head rest of a car seat saves us from  
(a) Head injury (b) Neck injury (c) Brain injury (d) Hear injury
52. If displacement = 15 m and time t=10 seconds, then average velocity is:  
(a) 12.5 m/s (b) 1.5 m/s (c) 2.5 m/s (d) 3 m/s
53. If we are standing in bus and when driver apply a brake the we feel  
(a) Psudo force pushes backwards (b) Psudo force pushes forwards  
(c) Real force pushes backwards (d) Real force pushes forwards
54. If we are moving with constant velocity frame then the inertial state is same as  
(a) Rest frame (b) Uniformly accelerated frame  
(c) Non-inertial frame (d) All of these
55. Average velocity is defined as  
(a) Displacement/time (b) Distance/time  
(c) Distance  $\times$  time (d) Displacement  $\times$  time
56. When a stone is thrown horizontally with 2 m/s from a building of height 5 m then just before hitting ground its acceleration is:  
(a)  $12\text{ m/s}^2$  (b)  $9.8\text{ m/s}^2$  (c)  $13\text{ m/s}^2$  (d)  $7.6\text{ m/s}^2$
57. A car travels 30 m toward east, then it takes turn and travels 40 m towards west. It takes 50 seconds. Its average velocity is:  
(a) -10 m/s (b) -1/5 m/s (c) 7/5 m/s (d) -5 m/s
58. Horizontal velocity vs time graph for a projectile motion is:  
(a) Straight line (b) Horizontal straight line  
(c) Parabola (d) Non-linear

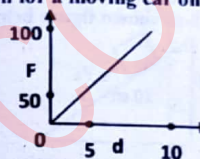
Sr.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.
Ans:	b	c	c	a	d	b	b	b	b	b	a	a	b	b	b

## UNIT 02 &gt;&gt;

## WORK AND ENERGY

## PRACTICE TEST NO. 1

1. Work done on a body is negative. If the angle between force and displacement is:  
(a) Less than  $90^\circ$  (b) Equal to  $90^\circ$  (c) Greater than  $90^\circ$  (d) Zero
2. If force-displacement graph for a moving car on a straight road is shown in figure below then its change in K.E will be



- (a) 100J (b) 200J (c) 500J (d) 1000J
3. The ratio of unit of power to unit of work is the unit of:  
(a) Mass (b) Length (c) Time (d) Frequency
4. If a pump lift  $100\text{m}^3$  water from ground to a height of 10m in 5min then its power will be?  
(a) 5KW (b) 50KW (c) 33KW (d) 20KW
5. If reference point is choosen at infinity the gravitational P.E of a body on the surface of earth given as  
(a) mgh (b)  $-\frac{GMm}{r}$  (c)  $-\frac{GMm}{R}$  (d) all
6. If a body moving with the velocity  $4\text{m/s}$  has K.E 16J. What will be its K.E if it is moving with velocity  $3\text{m/s}$ .  
(a) 2J (b) 5J (c) 9J (d) 11J
7. A satellite is moving in a circular path with uniform speed then work done on the satellite is:  
(a) Positive (b) Negative  
(c) Positive and maximum (d) Zero
8. A body falls from a tower. After falling a distance d the velocity of the body will be?  
(a)  $\sqrt{gd}$  (b)  $\sqrt{gd/2}$  (c)  $\sqrt{2gd}$  (d)  $\sqrt{2g/d}$
9. A body falls freely under gravity, its velocity is v when it has lost a P.E of U. Then the mass of body is:  
(a)  $2U/v^2$  (b)  $U/2v^2$  (c)  $U/2v$  (d)  $U/v^2$
10. In the presence of air friction the relation for falling body is:  
(a)  $mgh = \frac{1}{2}mv^2$  (b)  $mgh = \frac{1}{2}mv^2 + fh$   
(c)  $mgh = fh - \frac{1}{2}mv^2$  (d)  $mgh = fg + \frac{1}{2}mv^2$
11. In an explosion a bomb breaks up into two pieces of unequal masses. In this case:  
(a) Lighter part will have more momentum (c) Both parts will have equal K.E  
(b) Heavier will have more momentum (d) Bothe parts have numerically equal momentum
12. A body moves a distance of 10m along a straight line under the action of a force of 5N. If the work done is 25J, the angle which the force makes with the direction of motion of body is:  
(a)  $0^\circ$  (b)  $90^\circ$  (c)  $30^\circ$  (d)  $60^\circ$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Ans:	c	c	d	c	c	c	d	c	b	b		d

13. A light and heavy body have equal momentum. Which one has greater K.E?

- (a) Heavy body (b) Light body (c) K.E are equal (d) Data is incomplete

14. A light and heavy body have equal K.E. Which one has a greater momentum?

- (a) Light body (b) Heavy body (c) Both have equal momentum (d) It is not possible to say anything without additional information

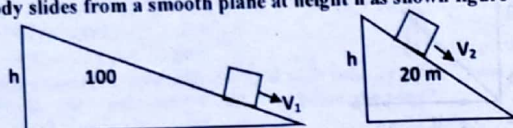
15. The consumption of energy by 60 watt bulb in 2s is:

- (a) 60J (b) 10J (c) 30J (d) 120J

16. The engine of the car applies the force of 2000 N by which it moves with a uniform velocity of 72km/h. The power delivered by engine is:

- (a) 2kW (b) 144kW (c) 44kW (d) 40kW

17. A body slides from a smooth plane at height  $h$  as shown figure below then:



- (a)  $v_1 = v_2$  (b)  $v_1 > v_2$  (c)  $v_1 < v_2$  (d)  $v_1 = v_2 = 0$

18. Which among the following is a form of energy:

- (a) Light (b) Momentum (c) Power (d) Pressure

19. A man does a given amount of work in 10s. Another man does the same amount of work in 20s. The ratio of the output power of first man to second man is:

- (a) 1 (b) 2/1 (c) 1/2 (d) None of these

20. Dimensions of power are

- (a)  $ML^2T^{-3}$  (b)  $ML^2T^{-2}$  (c)  $MLT^{-1}$  (d)  $MLT^{-2}$

21. In which of the following case work done is zero

- (a) Work done by a man pulling a cart on smooth surface  
(b) Work done by engine accelerating the car  
(c) Work done in pushing a rigid wall  
(d) Work done by gravity on a falling body

22. If a body of mass 2kg is raised to a height of 5m then work done by gravity will be

- (a) 10J (b) 100J (c) -100J (d) Zero

23. Type of energies possessed by moving car and stretched spring are respectively

- (a) P.E and K.E (b) K.E and P.E (c) K.E and K.E (d) P.E and P.E

24. Work done by gravity on a simple pendulum in one vibration is

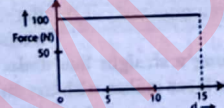
- (a) Zero (b) Positive  
(c) Negative (d) Depends upon initial position

25. If a block of mass 20kg is pushed along the surface of a inclined plane upto a height of 20m from the ground then T.E possessed by block at the top of the plane will be

- (a) 2000J (b) 4000J (c) 6000J (d) 8000J

26. If electron, proton, neutron and alpha particle are moving with same K.E then which one is moving faster

- (a) Electron (b) Proton (c) Neutron (d) Alpha-particle



Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Ans:	b	b	d	d	a	a	b	a	c	b	b	a	b	a

27. If  $\vec{F}$  is force required to sustain the motion of a car with velocity  $\vec{v}$  then power of the engine will be

- (a)  $Fv$  (b)  $\frac{1}{2}Fv$  (c)  $\frac{mv^2}{2t}$  (d) Zero

28. At which of the following angle between force and displacement the work done will be negative

- (a)  $30^\circ$  (b)  $60^\circ$  (c)  $90^\circ$  (d)  $120^\circ$

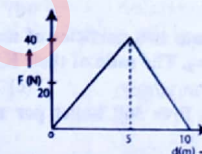
29. If velocity of a body of mass 10kg is increased from  $5\text{ms}^{-1}$  to  $10\text{ms}^{-1}$  then work done on the body is

- (a) 275J (b) 375J (c) 750J (d) 920J

30. A 70 kg man run upstairs in 10sec If vertical height of stairs is 8m then his power will be about

- (a) 650W (b) 548W (c) 340W (d) 3.4KW

31. If force-displacement graph for a body is shown in the figure below then the change in energy of the body will be



- (a) 200J (b) 400J (c) 500J (d) Zero

32. If a 1KW motor pulls a load by a distance 20m in 40sec then force exerted by the motor is

- (a) 100GN (b) 2000N (c) 4000N (d) 5000N

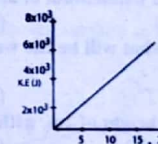
33. A brick of mass 2.5kg falls from height 6m above the ground After covering a distance 2m its K.E will be about.

- (a) 25J (b) 50J (c) 100J (d) 150J

34. Work done in stacking ten bricks one on the top of another if mass of each bricks is 'm' and thickness is 'h'

- (a) mgh (b) 10mgh (c) 25mgh (d) 45mgh

35. Change in kinetic energy of a car with time is shown in figure below. Ignoring frictional forces what is power of the engine?



- (a) 200W (b) 400W (c)  $16 \times 10^4 \text{W}$  (d) zero

36. When a spring is stretched, work done by stretching force is

- (a) Positive (b) Negative (c) Zero (d) None of these

37. Man moves a roller through a distance of 20 m. 10N of applied force is inclined of  $60^\circ$  of direction of motion what will be the work done by the man.

- (a) 100 J (b) 50J (c) -100J (d) -50J

Sr.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
Ans:	a	d	b	b	a	b	b	d	b	a	a

38. Work has the dimension as that of

- (a) Torque (b) Momentum  
(c) Power (d) Angular momentum

39. KE of body is increased by 44%. What is the percentage increase in the momentum.

- (a) 10% (b) 20% (c) 30% (d) 44%

40. Work done by a conservation force in a complete cycle is:

- (a) Zero (b) More than zero (c) Less than zero (d) None of these

41. Work is done on a body if:

- (a) Its energy increases (b) Its energy decreases  
(c) It covers displacement in direction of force (d) All of these

42. When two electrons are brought closer to each other then their P.E.:

- (a) Increase (b) Decrease  
(c) Remain same (d) May increase or decrease

43. A stationary particle explodes into two particles of masses  $m_1$  and  $m_2$  which moves in opposite directions with velocities  $v_1$  and  $v_2$ . The ratio of their K.E.:

- (a) 1 (b)  $m_1 v_1 / m_2 v_2$  (c)  $m_1 / m_2$  (d)  $m_2 / m_1$

44. From an automatic gun a man fires 360 bullet per minute with a speed of 360Km/h. If each weighs 20g the power of gun is:

- (a) 600 W (b) 300 W (c) 75 W (d) 150W

45. It is easier to push or pull an object when force is

- (a) Parallel to displacement  
(b) Perpendicular to displacement  
(c) Anti-parallel to displacement  
(d) Both a and c

46. If a 100kg car is accelerated from rest to a velocity  $10\text{ms}^{-1}$  then work done by engine will be

- (a) 1KJ (b) 0.5KJ (c) 5KJ (d) Zero

47. If K.E of a body having velocity  $v$  and momentum  $P$  is  $X$  then K.E of the body having velocity ' $2v$ ' and momentum  $2p$  will be

- (a)  $X$  (b)  $2X$  (c)  $4X$  (d)  $8X$

48. The K.E of a body of mass 2kg and momentum of 2Ns is:

- (a) 1J (b) 3J (c) 2J (d) 4J

49. A variable force  $F = x$  is applied what will be the work done in moving the particle from  $x = 0$  to 1:

- (a) 2 J (b) 1 J (c) 0.5 J (d) 5 J

50. A body of mass 10 kg moving at a height of 2m, with uniform speed of 2 m/s has total energy.

- (a) 316 J (b) 216 J (c) 392 J (d) 416 J

Sr.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	b	a	d	a	d	a	a	c	a	c	c	b

## PRACTICE TEST NO. 2

1. An object is displaced from point  $A(0,0,1)\text{m}$  to point  $B(1,4,3)\text{m}$  under a constant force  $F = (i + 2j + 3k)$ , find the work done by this force in this process

- (a) 13 J (b) 15 J (c) 0 (d) 13 J

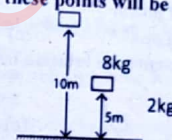
2. Two forces of 5N and 15N are working on a body in opposite direction. If body displaced by 5m in direction of net force, what will be the work done by net force:

- (a) 50 J (b) -50 J (c) 25 J (d) 100 J

3. An object of mass ' $m$ ' is projected vertically upward with initial velocity  $v$  then the maximum height reached by object is directly proportional to

- (a)  $v$  (b)  $v^2$  (c)  $\sqrt{v}$  (d)  $Mv$

4. Two bodies of masses 2kg and 8kg are placed at different heights as shown in figure below then the ratio of their potential energies at these points will be



- (a) 1:1 (b) 1:2 (c) 2:1 (d) 1:4

5. A bullet of mass  $m$  is moving horizontally with speed  $v$  is stopped by sand in its path. If it covers distance  $d$  before coming to rest then average retarding force acting on the bullet will be

- (a)  $\frac{mv^2}{d}$  (b)  $\frac{mv^2}{2d}$  (c)  $\frac{2mv^2}{d}$  (d)  $\frac{mv^2}{4d}$

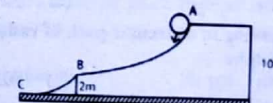
6. A ball of mass  $1/2\text{kg}$  is released from a height of 50m and after rebound it reaches to height of 10m. The percentage loss in energy will be

- (a) 20% (b) 40% (c) 60% (d) 80%

7. If a boat propeller engine exerts a force of 100N to overcome the drag force and move the boat with constant velocity  $20\text{ms}^{-1}$  then power of the engine will be

- (a) 500W (b) 2000W (c) 5000W (d) Zero

8. A ball of mass 1kg rolls down from a smooth surface as shown in figure below then its speed at the ground will be



- (a)  $1.4\text{ms}^{-1}$  (b)  $7\text{ms}^{-1}$  (c)  $14\text{ms}^{-1}$  (d)  $20\text{ms}^{-1}$

9. A body of mass 2kg is thrown vertically upward with kinetic energy 300J then maximum height attained by it will be

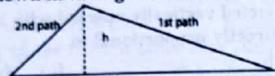
- (a) 5m (b) 10m (c) 15m (d) 20m

10. Four motors having different powers are kept running for different time. Which motor does the most work.

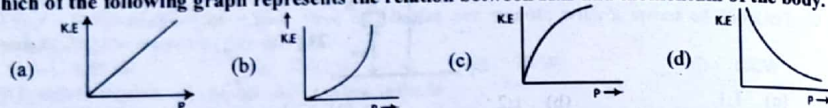
	Power	Time
(a)	100W	500sec
(b)	200W	2 min
(c)	500W	5 min
(d)	1000W	200sec

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Ans:	b	a	b	b	b	d	b	c	c	d

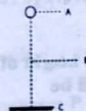
11. Two bodies of masses 2g and 32g are moving with same K.E then the ratio between their velocities will be  
(a) 1:2 (b) 4:1 (c) 1:4 (d) 16:1
12. A man pushes a cart with a force 100N through a distance 50m. If the work done by man is 350J then the angle between force and displacement will be  
(a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $120^\circ$
13. An object of mass  $m$  is moved from ground to a height  $h$ . If  $W_1$  and  $W_2$  are work done by force of gravity along 1<sup>st</sup> and 2<sup>nd</sup> path as shown in the figure below then



- (a)  $W_1 > W_2$  (b)  $W_1 < W_2$  (c)  $W_1 = W_2$  (d)  $W_1 = W_2 = 0$
14. Which of the following is not unit of power  
(a)  $\text{Js}^{-1}$  (b)  $\text{Erg} \cdot \text{min}^{-1}$  (c)  $\text{Kgm}^2 \cdot \text{s}^{-3}$  (d)  $\text{Wm}^{-2}$
15. Which of the following graph represents the relation between K.E and momentum of the body.



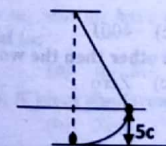
16. If a ball is dropped from a certain height at shown in the figure below, then ball will have maximum energy at point



- (a) A (b) B (c) C (d) Same at all point
17. Power of an electric pump which can pump  $10\text{m}^3$  water to a height of 10m in 5minutes  
(a) 3.3KW (b) 1.66KW (c) 33KW (d) 7.3KW
18. Absolute P.E of a body on the surface of earth is give as  
(a)  $-\frac{GMm}{r}$  (b)  $+\frac{GMm}{r}$  (c)  $-\frac{GMm}{R}$  (d) Zero
19. If a particle of mass 1kg is moving in a circular path of radius 0.5m with uniform speed  $5\text{ms}^{-1}$  then work being done on it will be  
(a) Zero (b) 10J (c) 50J (d) 100J
20. Work done by gravitational force in a closed path is  
(a) Always zero (b) Always positive (c) Always negative (d) May be +ve or -ve but never zero
21. In the above question the work done by gravity will be  
(a) -300J (b) -400J (c) -500J (d) -700J
22. A 20kg object is moving with velocity  $5\text{ms}^{-1}$ . If a force of 20N acts on it for displacement 10m change in its K.E will be  
(a) 100J (b) 200J (c) 300J (d) 400J
23. Necessary condition for work is being done on the body is  
(a) Force applied on the body (b) Displacement covered by body (c) Displacement is covered by body in the direction of force (d) Displacement is covered by body perpendicular to force

Sr.	11	12	13	14	15	16	17	18	19	20	21	22	23
Ans.	b	d	c	d	b	c	b	c	c	a	a	b	c

24. Scalar product of force and velocity is  
(a) Pressure (b) Work (c) Momentum (d) Power
25. The power of pump, which can pump 20 kg of water to a height of 50m in 10s will be:  
(a)  $2 \times 10^3$  watt (b)  $4 \times 10^3$  watt (c)  $20 \times 10^3$  watt (d)  $60 \times 10^3$  watt
26. If a man increase his speed by 2 m/s, his K.E becomes 4 times, the original speed of man is:  
(a) 2 m/s (b) 1 m/s (c) 0.5 m/s (d) 4 m/s
27. If the increase in the K.E of a body is 22%, then the increase in the momentum will be about:  
(a) 22% (b) 44% (c) 300% (d) 10%
28. A 1 kg body falls from 100m high tower. After falling 20m its K.E will be:  
(a) 200J (b) 2000J (c) 800J (d) 8000J
29. At which angle between F and d work done will be minimum?  
(a)  $0^\circ$  (b)  $90^\circ$  (c)  $30^\circ$  (d)  $45^\circ$
30. If a water falls from dam into a turbine wheel 19.6m below. Then the velocity of water at turbine:  
(a) 29.2m/s (b) 9.8 m/s (c) 98m/s (d) 19.6m/s
31. If velocity of a body is twice of previous velocity, then K.E will become:  
(a) 2 times (b) 1 times (c)  $\frac{1}{2}$  times (d) 4 times
32. A spring with spring constant K when stretched through 1cm, the potential energy is U. If it is stretched by 4cm. The potential energy will be:  
(a) 16 U (b) 14U (c) 8 U (d) 2 U
33. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that:  
(a) Its acceleration is constant (b) It moves in a straight line (c) Its velocity is constant (d) Its K.E is constant
34. A ball of mass  $m$  moves with speed  $v$  and strikes a wall having infinite mass and returns with same speed then the work done by the ball on the wall is:  
(a) Zero (b)  $m/v$  J (c)  $mv$  J (d)  $v/m$  J
35. A 50kg man with 20kg load on his head climbs up 20 steps of 0.25m height each. The work done in climbing is:  
(a) 100J (b) 5 J (c) 3430J (d) 350J
36. You lift a heavy book from the floor of the room and keep it in the book-shelf having a height 2m. In this process you take 5s. the work done by you will depend on:  
(a) Mass of the book and time taken (b) Height of book shelf and time taken (c) Mass of the book, height of book shelf and time taken (d) Weight of the book and height of book shelf
37. What is velocity at mean position when pendulum moves from extreme to mean position as shown in the fig below.



- (a) 0.1m/s (b) 0.5m/s (c) 1m/s (d) 1.4m/s
38. 1 hp is equal to:  
(a) 746J (b) 746W (c) 746KW (d) 746MWh

Sr.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Ans.	d	a	a	d	a	b	d	d	a	d	a	c	d	c	b

39. A 4kg body is thrown vertically upward from the ground with a velocity of  $5\text{ms}^{-1}$ . Its K.E just before hitting the ground is:

- (a) 8W (b) 6W (c) 10W (d) 14W

40. 1MWh is equal to

- (a)  $36 \times 10^8 \text{J}$  (b) 3.6J (c) 3.6MJ (d)  $3.6 \times 10^9 \text{J}$

41. A 2kg body falls from a high tower. After falling 100m, its K.E will be:

- (a) 0.2KJ (b) 1KJ (c) 2KJ (d) 20KJ

42. Four particles have same K.E, then which has maximum momentum:

- (a) Proton (b) Electron (c) Positron (d)  $\alpha$ -particle

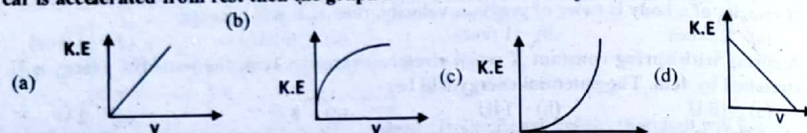
43. If escape velocity is  $v_1$  for a 10kg mass and  $v_2$  for a 20kg mass then

- (a)  $v_1 = v_2$  (b)  $v_1 > v_2$  (c)  $v_1 < v_2$  (d)  $v_1 \gg v_2$

44. If velocity of body becomes  $n$  times then its K.E will become

- (a)  $n$ -times (b)  $n^2$ -times (c)  $2n$ -times (d)  $vn$ -times

45. A car is accelerated from rest then the graph between its K.E and speed will be



46. A boat propeller moving with velocity 10m/s has maximum power 500W then the force exerted by the propeller is:

- (a) 5N (b) 50N (c) 500N (d) 5000N

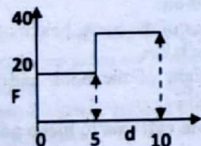
47. If a body covers a displacement 10m with rate of change of momentum  $10\text{kgms}^{-2}$ , then work on the body is

- (a) 5J (b) 50J (c) 100J (d) 0.1J

48. A car is moving with uniform velocity then the work done by engine, friction, and net force are ..... respectively

- (a) +ve, -ve, zero (b) -ve, zero, +ve (c) -ve, zero, +ve (d) +ve, zero, -ve

49. Force-displacement graph of a body is shown in the figure below. Then change in energy of the body is



- (a) 40J (b) 300J (c) 400J (d) 800J

50. If acceleration and velocity are perpendicular to each other then the work done on the body is:

- (a) Positive (b) Negative (c) Zero (d) Maximum

43.	44.	45.	46.	47.	48.	49.	50.
b	d	d	d	a	b	c	b

1. Which of the following is the greater value of work?

- (a) 100J (b) 300J (c) -300J (d) -500J

2. A person holding a bag of 10kg moving with the velocity of 20m/s then the work done by gravity is

- (a) 10Nm (b) 20Nm (c) 200Nm (d) Zero

3. Which of the following is not a unit of power?

- (a) W (b) Horse power (c) erg/s (d) W-hour

4. If momentum of the body is increased by 100% then its K.E will increase by:

- (a) 100% (b) 200% (c) 300% (d) 400%

5. Area under the graph between force and velocity will give:

- (a) Work done (b) Power (c) K.E (d) Total energy

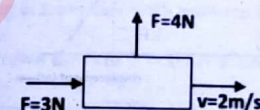
6. When a person lifts a body from the ground the work done by his applied force is?

- (a) Positive (b) Negative (c) Zero (d) 1

7. Work done by simple pendulum in one complete oscillation is:

- (a) Mgd (b)  $\frac{1}{2\pi} \sqrt{\frac{L}{gd}}$  (c) Zero (d)  $\frac{mgd}{2}$

8. What is the power of the body if forces acting on a moving body are shown in the figure below:



- (a) 8W (b) 6W (c) 10W (d) 14W

9. A diver weighing 200N jumps from a 10m high board. What will be its velocity when its height is 6m?

- (a) 3m/s (b) 6m/s (c) 9m/s (d) 12m/s

10. Which of the following is a scalar quantity:

- (a) Work (b) Electric field (c) Acceleration (d) Displacement

11. A force of 5N acts on a 15kg body initially at rest. The work done by the force during the first second of motion of the body is:

- (a) 75J (b) 5/6J (c) 6J (d) 5J

12. A force  $F = 8\hat{i} + 3\hat{j}$  newton is applied over a particle which displaces it from its origin to the point  $r = 2\hat{i} - 1\hat{j}$  meters. The work done on the particle is:

- (a) -7J (b) 11J (c) 13J (d) 7J

13. Two bodies of masses  $m_1$  and  $m_2$  have equal K.E. If  $p_1$  and  $p_2$  are their respective momentum, then ratio  $p_1:p_2$  is equal to:

- (a)  $m_1:m_2$  (b)  $m_1^2:m_2^2$  (c)  $\sqrt{m_2}:\sqrt{m_1}$  (d)  $\sqrt{m_1}:\sqrt{m_2}$

14. A force of  $2\hat{i} + 4\hat{j} + 6\hat{k}$  N gives displacement of 10m. The work done is:

- (a) 20J (b) Zero (c) 26J (d) 40J

15. Energy required to accelerate a car from 10 to  $20\text{ms}^{-1}$  compared with that required to accelerate from 0 to 10 m/s in the same interval of time covering the same distance is:

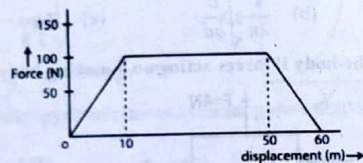
- (a) Three times (b) Twice (c) Four times (d) Same

16. A body falls from the height  $h$ . After falling a distance  $S$  its speed will be:

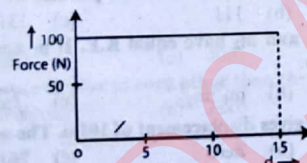
- (a)  $\sqrt{2gh}$  (b)  $\sqrt{2gS}$  (c)  $\sqrt{2g(h-S)}$  (d)  $\sqrt{2g(S-h)}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Ans:	d	d	d	c	b	a	c	b	c	a	b	c	c	d	a	b

17. A ball is released from a certain height. It loses 50% of its K.E on striking the ground. It will attain a height again equal to:  
 (a) One fourth the initial height (b) Half the initial height  
 (c) Three fourth the initial height (d) None of these
18. A force of  $2\hat{i} + 3\hat{j} + 4\hat{k}$  N acts on a body for 4s, produces a displacement of  $3\hat{i} + 4\hat{j} + 5\hat{k}$  m. The power is:  
 (a) 9.5 W (b) 7.5 W (c) 4.5 W (d) 6.5 W
19. Work done on the body depends upon  
 (a) Force applied on the body  
 (b) Displacement covered by the body  
 (c) Angle between force and displacement  
 (d) All of these
20. A man pushes a lawn mover through a distance 50m by a force 10N which makes an angle  $45^\circ$  with horizontal, what is work done by man  
 (a) 250J (b) 350J (c) 450J (d) 500J
21. If force-displacement graph for a body is shown in the figure below then work done on the body is



- (a) Zero (b) 5KJ (c) 6KJ (d) 10KJ
22. Absolute P.E of an object is minimum  
 (a) On the surface of earth (b) At infinity  
 (c) At the center of earth (d) At a height equal to radius of earth
23. Energy consumed by a 500W bulb in 10h is  
 (a) 0.5KWh (b) 5KWh (c) 5KJ (d) 50MJ
24. If 5000kg aero plane is moving in a vertical circle of radius 1km then work done by gravity during its motion from lowest point to highest point will be  
 (a) Zero (b)  $-5 \times 10^7 J$  (c)  $-1 \times 10^8 J$  (d)  $5 \times 10^8 J$
25. Force-displacement graph for a falling body is shown in the figure below. What is gain in K.E of the body after 10m.



- (a) 1J (b) 1KJ (c) 1.5J (d) 1.5KJ
26. show force-displacement graph is shown in the figure below What is net change in energy of a body?

Sr.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Ans:	b	a	d	b	b	a	b	c	b	d

27. A 2kg ball moving with velocity  $10\text{ms}^{-1}$  is brought to rest in 20 sec What is work done on the ball?  
 (a) -5J (b) -50J (c) -100J (d) -200J
28. If both mass and velocity of a body are doubled then its K.E will become  
 (a) Double (b) Four times (c) Eight times (d) Sixteen times
29. If a half kg ball is moving with constant velocity  $(4\hat{i} + 3\hat{j})\text{ms}^{-1}$  then its K.E will be  
 (a) 3.7J (b) 6.25J (c) 12.5J (d) 15.75J
30. If a car is decelerating down from a hill station then its K.E and P.E  
 (a) Increase and decrease (b) Decrease and increase  
 (c) Both decrease (d) Both increase
31. If a 1kg body is moving with kinetic energy 200J then its momentum will be  
 (a) 10 N.s (b) 20 N.s (c) 25 N.s (d) 50 N.s
32. If an object of mass 2kg dropped from a height 15m then its velocity at a height 10 will be  
 (a)  $4\text{ms}^{-1}$  (b)  $10\text{ms}^{-1}$  (c)  $14\text{ms}^{-1}$  (d)  $19\text{ms}^{-1}$
33. Effect of work is equal to  
 (a) Change in total energy (b) Change in kinetic energy  
 (c) Change in power (d) Both a & b
34. If a horse pulls a cart, work done by horse is  
 (a) Negative (b) Zero (c) Positive (d) None of these
35. If momentum is increased by 20% then K.E. increase by:  
 (a) 20% (b) 40% (c) 44% (d) 86%
36. A body of mass 10 kg is travelling with uniform speed of 5 m/s. Its kinetic energy is  
 (a) 125 J (b) 250 J (c) 500 J (d) 255 J
37. A stone of 1 kg is thrown upward it reaches a max height of 5m, work done by the gravity is:  
 (a) 50 J (b) 49 J (c) -49 J (d) 55 J
38. The linear momentum is increased by 10%, percentage change in the kinetic energy will be:  
 (a) 21% (b) 11% (c) 22% (d) 10%
39. The SI unit of power is?  
 (a) Hz (b) Sec (c) Watt (d) Joules
40. A block of mass 50 kg slide over a horizontal distance of 1 m, if the coefficient of between the surfaces is 0.2 then work done against friction is  
 (a) 98J (b) 72J (c) 56J (d) 34J
41. A block of mass 60 kg just slides over a horizontal distance of 0.9 m. If the coefficient of friction between their surfaces is 0.15 then work done against friction will be:  
 (a) 79.4 J (b) 97.54 J (c) 105.25 J (d) 81 J
42. The value of acceleration due to gravity on moon is \_\_\_\_\_ of earth:  
 (a) One forth (b) 1/10 th (c) 2/3 (d) 1/6
43. If force is  $F = 4\hat{i} - 2\hat{j}$  and displacement is  $d = 3\hat{i} + 4\hat{j}$ , the work done will be:  
 (a) 4 J (b) 8 J (c) 2 J (d) 12 J
44. In which of the following the work is done by the variable force  
 (a) Extension produced in spring (b) Rocket moving away from earth  
 (c) Charges moving toward each other (d) All of these
45. When mass and speed of the body are doubled, K.E of body will become:  
 (a) 4 times (b) 8 times (c) 6 times (d) Unchanged
46. A neutron of mass  $1.67 \times 10^{-27}\text{kg}$  covers a distance 12m in  $3.6 \times 10^{-4}\text{sec}$  with uniform speed what is K.E of neutron  
 (a)  $9.3 \times 10^{-9}\text{J}$  (b)  $9.3 \times 10^{-14}\text{J}$  (c)  $9.3 \times 10^{-19}\text{J}$  (d)  $9.3 \times 10^{-29}\text{J}$

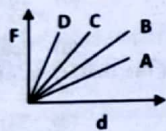
Sr.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	c	c	b	c	b	b	d	c	c	a	c	a	c	a	d	d	a	d	b	c

47. When velocity of body of mass 10kg is increased from  $4\text{ms}^{-1}$  to  $10\text{ms}^{-1}$  then work done on the body is:  
 (a) 30J (b) 220J (c) 320J (d) 420J
48. A particle moves from point P(1,2,3) to Q(2,1,4) under the action of a constant force  $F=(2i+j+k)$ , work done by force is:  
 (a) 2J (b) 4J (c) 16J (d) 8J
49. An object is displaced from point A (2,3,4) m to point B (1,2,3) m under a constant force  $F=(2i+3j+4k)$ , find the work done by this force in this process:  
 (a) 9J (b) 0 (c) -9J (d) 20J
50. Area of force-displacement curve gives the information about  
 (a) Power (b) Impulse (c) Force (d) Work

Sr.	47	48	49	50
Ans:	d	a	c	d

## PRACTICE TEST NO. 4

1. At which of the following angle between force and displacement, work is maximum:  
 (a) 20 (b) 40 (c) 60 (d) 90
2. A force of 40N acts on a body and it covers the displacement 2m. If the work done on the body 40J then angle between force and displacement is  
 (a)  $\pi/3\text{rad}$  (b)  $\pi/2\text{rad}$  (c)  $\pi/6\text{rad}$  (d)  $\pi/2\text{rad}$
3. If force-displacement graph for different bodies is shown in the figure below then the work done is maximum for:



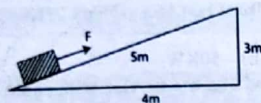
- (a) A (b) B (c) C (d) D
4. Which of the following force is not a conservative force?  
 (a) Elastic force (b) Friction  
 (c) Gravitational force (d) Electric force
5. A 1000W motor runs for 1h then work done by the motor is:  
 (a) 3.6J (b) 3.6KJ (c) 3.6MJ (d) zero
6. Which of the following is used as unit of electrical energy?  
 (a) J (b) Ev (c) erg (d) KWh
7. Two bodies of equal masses are moving with velocities 2m/s and 6m/s then ration between their K.E will be:  
 (a) 1:3 (b) 3:1 (c) 1:9 (d) 9:1
8. For which of the following force the work done depends on the path followed  
 (a) Electric force (b) Gravitational force  
 (c) Frictional force (d) Elastic force

Sr.	1	2	3	4	5	6	7	8
Ans:	a	a	b	b	c	d	c	c

9. A 1000kg car is moving with velocity 36Km/h. When breaks are applied, it covers 10m distance before coming to rest. Then retarding force acting on the car is:  
 (a) 50N (b) 500N (c) 5000N (d) 2000N
10. If a force required to accelerate the particle from rest to velocity  $v$  is  $F$ . Then force required to accelerate the particle to velocity  $2v$  in same distance will be:  
 (a)  $F$  (b)  $F/2$  (c)  $2F$  (d)  $4F$
11. A force  $F=2i$  is acting on a car moving with constant velocity  $V=3i+5j$  then power of the engine is:  
 (a) 6 (b) 16 (c) 10 (d) Zero
12. Work done may be equal to:  
 (a) Change in K.E (b) Change in electric P.E  
 (c) Change in P.E (d) All of these
13. If a 1000 kg car accelerates from rest to a velocity 72Km/h in 4sec then the power produced by engine is:  
 (a) 5KW (b) 50KW (c) 500KW (d) 5000KW
14. Two bodies of masses 1kg and 4kg are moving with equal K.E. The ratio of their linear momentum is:  
 (a) 1:4 (b) 4:1 (c) 1:2 (d) 2:1
15. A man pushes a wall and fails to displace it. He does:  
 (a) Negative work (c) Positive but not maximum work  
 (b) No work (d) Maximum work
16. A body of mass 10kg is dropped to the ground from the height of 10m. the work done by the gravitational force is:  
 (a) -980J (b) 980J (c) 490J (d) -490J
17. The same retarding force is applied to stop a train. The train stops after 80m, If the speed of train is doubled under same retarding force stopping distance will be:  
 (a) Halved (b) Four times (c) Doubled (d) The same
18. If force and displacement of particle in direction of force are doubled. Work will become:  
 (a) One forth times (b) 4 times (c) Half (d) Double
19. Two bodies of masses 1kg and 5kg are dropped gently from the top of the tower. At the point 20cm from the ground, both the bodies will have the same (ignoring air friction):  
 (a) Velocity (b) Total energy (c) K.E (d) Momentum
20. Two bodies of different masses  $m_1$  and  $m_2$  have equal momentum. Their Kinetic energies  $E_1:E_2$  are the ratio:  
 (a)  $m_1^2:m_2^2$  (b)  $\sqrt{m_1}:\sqrt{m_2}$  (c)  $m_2:m_1$  (d)  $m_1:m_2$
21. Two bodies are thrown vertically upward with their initial speeds in the ratio 2:3 then the ratio of the maximum heights attained by them is:  
 (a) 1:1 (b) 2:3 (c)  $\sqrt{2}:\sqrt{3}$  (d) 4:9
22. A body of mass 2kg is dropped from rest position 12m above the ground. At height 7m above ground its velocity is:  
 (a) 7m/s (b) 49m/s (c) 12m/s (d) 10m/s
23. A force  $F$  stops a body of mass  $m$  moving with velocity  $v$  in a distance  $S$ . The force required to stop a body double the mass moving with double the velocity in the same distance is:  
 (a)  $2F$  (b)  $8F$  (c)  $4F$  (d)  $6F$
24. In which case does the potential energy decrease:  
 (a) On compressing a spring (b) On the rising of an air bubble in the water  
 (c) On stretching a spring (d) On moving a body parallel the gravitational force

Sr.	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ans:	c	d	a	d	b	c	b	b	b	b	a	c	d	d	b	d

25. The K.E of body of mass 2kg and momentum of 2 Ns is:  
 (a) 1J (b) 2J (c) 4J (d) 3J
26. If a force F is applied on a body and it moves with a velocity v, the power will be:  
 (a)  $F \times v$  (b)  $F/v$  (c)  $F \times v^2$  (d)  $F/v^2$
27. Unit of work in terms of base unit is:  
 (a) Joule (b) Nm (c)  $\text{Kg m}^2 \text{s}^{-2}$  (d) all
28. Watt - hour is a unit of:  
 (a) Power (b) Energy (c) Impulse (d) Momentum
29. A man carries a 10kg bucket and covers a horizontal distance 2m then work done by gravity is  
 (a) Zero (b) 20J (c) 100J (d) 200J
30. A man pulls a 10kg cart by 100N force from the ground to the top of inclined plane as shown in the figure below

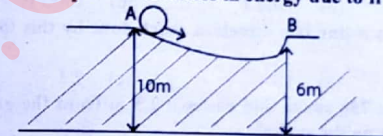


then work done by the man is

- (a) 300J (b) 400J (c) 500J (d) 700J
31. What is angle between force and displacement if work done on the body is only 50% of its maximum value  
 (a)  $30^\circ$  (b)  $45^\circ$  (c)  $60^\circ$  (d)  $70^\circ$
32. Area under force-displacement graph represents  
 (a) Work done on the body (b) Power of the body  
 (c) K.E of the body (d) P.E of the body
33.  $1\text{KWh} =$   
 (a) 3.6 MJ (b)  $3.6 \times 10^{13} \text{ erg}$  (c)  $5.76 \times 10^6 \text{ ev}$  (d) All of these
34. Increasing the distance from the surface of earth absolute P.E of an object  
 (a) Increases (b) Decreases  
 (c) Remains same (d) First increases then decreases
35. A 10kg mass is dropped from a height of 5m. If its K.E at the bottom is 300J then work done against friction is  
 (a) 100J (b) 200J (c) 300J (d) Zero
36. A body of weight 50 is dropped from a height of 10m. If work done against friction is 100J then its velocity at the surface of ground will be about  
 (a)  $5\text{ms}^{-1}$  (b)  $8\text{ms}^{-1}$  (c)  $13\text{ms}^{-1}$  (d)  $15\text{ms}^{-1}$
37. If both momentum and mass of a body are doubled then its K.E will become  
 (a) Double (b) Half (c) Four times (d) Remains same
38. If a particle of mass m is moving with kinetic energy E then its momentum will be  
 (a)  $\sqrt{mE}$  (b)  $\sqrt{2mE}$  (c)  $\sqrt{\frac{mE}{2}}$  (d)  $2mE$
39. Killowatt-hour is the work done in one hour by an agency whose power is  
 (a) 1000W (b)  $1000\text{ergs}^{-1}$  (c) 1000hp (d) All of these
40. By increasing the angle ( $0^\circ < \theta < 90^\circ$ ) between force and displacement work done on a body  
 (a) Increases (b) Decreases (c) Remains same (d) May increase or decrease

Sr.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	a	a	c	b	a	c	c	a	d	a	b	c	a	b	a	b

41. A horizontal force 10N acts on a stationary block of mass 2kg placed on a horizontal smooth surface. After 5sec the K.E of block will be  
 (a) 25J (b) 125J (c) 225J (d) 625J
42. Which of the following force will do work  
 (a) Centripetal force (b) Magnetic force (c) Gravitational force (d) Gravitational force on satellite
43. If an object is lying on the surface of earth then the energy required to move the object out of earth gravitational field is  
 (a)  $-\frac{GMm}{r}$  (b)  $+\frac{GMm}{r}$  (c)  $-\frac{GMm}{R}$  (d)  $+\frac{GMm}{R}$
44. Two balls of mass 10g and 40g are moving with same K.E the ratio of their linear momentum will be  
 (a) 1:2 (b) 2:1 (c) 1:16 (d) 16:1
45. If momentum of body is increase by 3% then its K.E will be increased by  
 (a) 1.5% (b) 3% (c) 6% (d) 9%
46. A ball of mass 0.5kg starts rolling on a rough curved surface from point (A) as shown in the figure below. If it comes to rest at point B then loss in energy due to friction will be



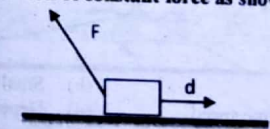
- (a) 10J (b) 20J (c) 50J (d) Zero
47. A 600N student run upstairs 50 steps each of height 10cm in 20 seconds. What is power of the student?  
 (a) 50W (b) 150W (c) 250W (d) 1500W
48. An object of mass 'm' is moving in a circular path of radius 'r' with uniform speed v then work done on it will be  
 (a)  $mv^2$  (b)  $2mv^2$  (c)  $\frac{1}{2}mv^2$  (d) Zero
49. Which of the following is not unit of power?  
 (a) Horse power (b) Kilowatt (c) kWh (d) Nm/s
50. In a simple pendulum work done by the tension force is  
 (a) Positive (b) Negative (c) Zero (d) None of these

Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	c	d	b	c	b	b	d	c	c

## PRACTICE TEST NO. 5

- A cyclist come to skidding stop in 10 m, the force on the cycle due to the road is 200 N and opposite to the motion. How much work does the cycle do on the road  
(a) 2000 J (b) -2000 J (c) 0 (d) 200 J
- When the direction of the force and displacement are opposite, work done is  
(a) Negative (b) Positive (c) Zero (d) None of these
- An electric filament bulb can be work from  
(a) D.C supply only (b) A.C supply only  
(c) Battery supply only (d) All of these
- A constant force  $F = 2i + 3j + 4k$  is applied on a body what will be the work done to move a body 5 m in z-direction:  
(a) 0 (b) 45 J (c) 10 J (d) 20 J
- A particle of mass 10 kg is moving with velocity  $10x^{1/2}$ , here x is displacement. The work done by net force during the displacement of particle from  $x = 4$  to  $x = 9$ .  
(a) 1250 J (b) 3500 J (c) 1000 J (d) 2500 J
- A force of  $F = 1 + y$  N is acting in y direction, work done by this force to move the particle from  $y = 0$  to  $y = 1$  m  
(a) 0.5 J (b) 1 J (c) 2 J (d) 1.5 J
- A 4kg eagle picks up a 75g snake and raises it 2.5 m from the ground to a branch. What is the work done by the eagle on the snake?  
(a) 100 J (b) 1.875 J (c) 18.75 J (d) 187.5 J
- A constant force of 10 N is applied on a body which causes displacement of 12 cm what will be the work done:  
(a) 120 J (b) 12 J (c) 1.2 J (d) 18 J
- When a man walks on a surface horizontally with constant velocity, work done by  
(a) Friction is zero (b) Contact force is zero  
(c) Gravity is zero (d) All of these
- When a momentum of body increased by 200%, its kinetic energy increases by  
(a) 200 % (b) 300 % (c) 400 % (d) 800 %
- Consider a drop of water of mass 1 gm falling from a height of 1 km. It hits the ground with a speed of 50 m/s, take  $g = 10 \text{ m/s}^2$ . The work done by resistive force of air is:  
(a) -8.25 J (b) -8.75 J (c) 8.75 J (d) -8.5 J
- 1 Joule is equal to:  
(a)  $10^4 \text{ erg}$  (b)  $10^5 \text{ erg}$  (c)  $10^6 \text{ erg}$  (d)  $10^7 \text{ erg}$
- At which angle work done is minimum:  
(a) 45 degree (b) 90 degree (c) 0 degree (d) 180 degree
- If mass and speed both are doubled kinetic energy will:  
(a) Increase 4 times (b) Increase 6 times  
(c) Increase 8 times (d) Increase 10 times
- An object is displaced from position vector  $r_1 = (2i + 3j) \text{ m}$  to  $r_2 = (4j + 6k) \text{ m}$  under a force  $F = (3i + 2j) \text{ N}$ . Find the work done by this force:  
(a) 10J (b) -4J (c) 83J (d) -83 J
- Which is the unit of energy:  
(a) Joule (b) Erg (c) Unit (Kwh) (d) All of these

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Ans:	a	a	d	d		d	b	a	d	d	b	d	b	c	b	d

- A horse is pulling a cart of mass 50 kg in the horizontal direction, if the distance travelled is 200 m then what will be the work done by the horse.  
(a) 1000J (b) -1000J (c) Zero (d) 500J
- A man holds a bucket by applying force 10 N, then moves a horizontal distance of 5 m and vertical distance of 10 m, find out the net work done  
(a) 100 J (b) 150 J (c) 50 J (d) 200 J
- A steel ball of mass 5 g is thrown downward with velocity 10 m/s from height 19.5m. It penetrates sand by 50 cm. The change in mechanical energy will be: ( $g = 10 \text{ m/s}^2$ )  
(a) 2 J (b) 2.25 J (c) 2.5 J (d) 2.75 J
- Two bodies of mass m and 4m moving with same kinetic energy, ratio between their velocities will be:  
(a) 4 : 1 (b) 2 : 1 (c) 1 : 4 (d) 1 : 2
- When work done by force of gravity is negative (only gravity is acting)  
(a) K.E decreases (b) P.E increases (c) Both A and B (d) None of these
- Maximum power delivered by battery is:  
(a)  $P_{\max} = E^2/4r$  (b)  $P_{\max} = rE^2$  (c)  $P_{\max} = VIT$  (d) Unlimited
- If the speed of body is doubled, then:  
(a) K.E doubled (b) PE doubled  
(c) Momentum doubled (d) Acceleration is doubled
- The value of quantity G in the law of gravitation  
(a) Depends on mass of Earth only  
(b) Depends on radius of Earth only  
(c) Depends on both  
(d) It independent of mass and radius of Earth
- Two forces of  $F_1 = 5 \text{ N}$  and  $F_2 = 15 \text{ N}$  are working on a body in opposite direction. If body displaced by 5 m in direction of net force. What will be the work done by  $F_1$ :  
(a) 25 J (b) -25 J (c) 50 J (d) 75 J
- When total work done on a particle is positive then:  
(a) KE remain constant (b) Momentum increase  
(c) KE decreases (d) All of these
- When brakes are applied to moving vehicle, the work done by the braking system is:  
(a) Positive (b) Negative (c) Zero (d) None of these
- A bullet of mass 10 g leaves a rifle at an initial velocity of 1000 m/s and strikes earth at the same level with a velocity of 500 m/s, the work in overcoming the resistance of air will be:  
(a) 500 J (b) 5000J (c) 3750 J (d) 475 J
- If a body is moving under the action of constant force as shown in the figure below then the work done on the body is  
  
(a) Positive (b) negative (c) maximum (d) Minimum
- Work done by a man pushing the rigid wall is zero because  
(a) force is zero (b) displacement is zero  
(c) force and displacement are parallel (d) force and displacement are perpendicular

Sr.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Ans:	a	a	b	b	b	a	c	d	b	b	b	c	b	b

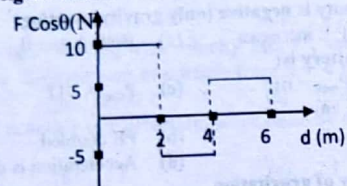
31. If a car is moving with uniform velocity then work done on the car by Engine, Friction and net force is respectively

- (a) positive, negative, positive  
(b) positive, negative, negative  
(c) positive, negative, zero  
(d) positive, zero, positive

32. If a force  $\vec{F} = 4\hat{i} + 6\hat{j}$  displaces the body from point  $P(2, 3)$  to a point  $Q(5, -2)$  then what is work done.

- (a) 9 J (b) -9 J (c) 18 J (d) -18 J

33. The graph between displacement and component of force in the direction of displacement for a body is shown in the figure below. Work done on the body is

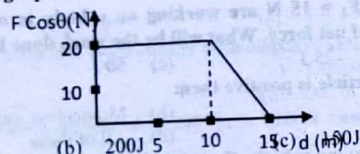


- (a) 20 J (b) 30 J (c) 40 J (d) 50 J

34. Force-displacement graph for a body is shown in the figure below. Work done on the body is

- (a) 7.5 J (b) 15 J (c) 750 J (d) 1500 J

35. Force-displacement graph for a body is shown in the figure below. Work done on the body is

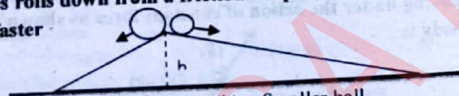


- (a) 50 J (b) 200 J (c) 150 J (d) 250 J

36. A person holding a 10 kg bag covers a displacement 5 m in horizontal direction. How much work is done by gravity

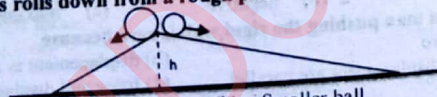
- (a) 50 J (b) 500 J (c) -500 J (d) zero

37. Two balls of different masses rolls down from a frictionless plane as shown in the figure below then which balls is moving faster



- (a) Bigger ball (b) Smaller ball  
(c) Both are moving with same speed (d) Depend up on path length

38. Two balls of different masses rolls down from a rough plane as shown in the figure below then which balls is moving faster



- (a) Bigger ball (b) Smaller ball  
(c) Both are moving with same speed (d) Depend up on path length

Sr.	31.	32.	33.	34.	35.	36.	37.	38.
Ans:	c	d	a	a	d	d	c	a

39. When the finite force is parallel to the direction of motion of the body is 50 N, the work done will be:

- (a) Minimum (b) Maximum (c) Infinity (d) Varies

40. Work has same dimensions as that of:

- (a) Torque (b) Power (c) Momentum (d) Force

41. If a body of mass 5 kg is raised vertically through a distance of 1 m, then work done is:

- (a) 49 J (b) 4.9 J (c) 490 J (d) 0.49 J

42. Area under force-displacement graph gives:

- (a) Velocity (b) Power (c) Work done (d) Acceleration

43. Scalar product of force and velocity is:

- (a) Work (b) Power (c) Energy (d) Acceleration

44. A body of mass 2 kg moving with velocity of  $4 \text{ ms}^{-1}$  has K.E equal to:

- (a) 16 J (b) 8 J (c) 32 J (d) 2 J

45. All the food we eat in one day has about the same energy as:

- (a) One liter of petrol (b)  $\frac{1}{2}$  liter of petrol  
(c)  $\frac{1}{3}$  liter of petrol (d)  $\frac{1}{4}$  liter of petrol

46. The ratio of dimensions of K.E and power is:

- (a) 1:1 (b)  $[T]:1$  (c)  $1:[T]$  (d)  $[M]:[T]$

47. A stone of mass 2 kg is dropped from the top of a tower of height 40 m. What will be its K.E 10 m below the top.

- (a) 19.6 J (b) 1960 J (c) 600 J (d) 196 J

48. A body has P.E = mgh, when it is at height "h" from the ground. At the point the distance "x" below from the top its P.E will be:

- (a) mgx (b) mgh (c)  $mg(x+h)$  (d)  $mg(h-x)$

49. If momentum of the body is halved its kinetic energy will become:

- (a) Doubled (b) Half (c) Four times (d) One fourth

50. If a body is falling through a height 10 m then its velocity at the ground will be:

- (a) 10 m/s (b) 14 m/s (c) 20 m/s (d) 25 m/s

Sr.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	a	a	c	b	a	c	b	d	d	d	b

## UNIT 03 &gt;&gt;

ROTATIONAL AND  
CIRCULAR MOTION

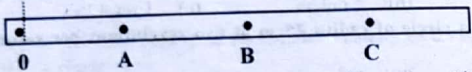
## PRACTICE TEST NO. 1

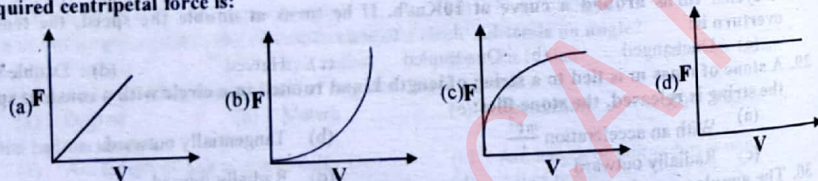
- Determine the angular velocity if 4.8 revolutions are completed in 4 seconds  
(a) 9.6 radian/sec (b) 7.5 radians/sec (c) 8 radians/sec (d) 0.96 radians/sec
- When a body moves in a circle of radius  $r$  with angular speed  $\omega$ , its centripetal acceleration is  
(a)  $\omega r$  (b)  $\omega^2 r$  (c)  $\omega r^2$  (d)  $\omega/r$
- A wheel whose radius is 50 cm rotates at an angular velocity of 6 rad/sec. The linear velocity of the rim of the wheel is closest to:  
(a) 1.5 m/s (b) 4.5 m/s (c) 3.0 m/s (d) 7.5 m/s
- Which of the following types of force can do no work on the particle upon which it acts:  
(a) Frictional Force (b) Gravitational force (c) Centripetal force (d) Elastic force
- A point on a wheel has a constant angular velocity of 3 rad/s. The angle turned through in 15 seconds is:  
(a) 45 rad (b)  $10\pi$  rad (c)  $90\pi$  rad (d) 5 rad
- Angle between radius vector and centripetal acceleration is  
(a)  $0^\circ$  (b)  $\pi$  (c)  $2\pi$  (d) None of these
- The angular displacement is assigned positive sign when the rotation is  
(a) Clockwise (b) Anti-clockwise (c) Perpendicular (d) Parallel
- The minute hand of a large clock is 3.0 m long. What is its mean angular speed?  
(a)  $1.4 \times 10^{-4} \text{ rad s}^{-1}$  (b)  $1.0 \times 10^{-3} \text{ rad s}^{-1}$  (c)  $5.2 \times 10^{-3} \text{ rad s}^{-1}$  (d)  $1.7 \times 10^{-3} \text{ rad s}^{-1}$
- What is 30 degrees in radians?  
(a)  $\pi/3$  (b)  $\pi/6$  (c)  $\pi/2$  (d)  $\pi/4$
- Angular displacement is a  
(a) Vector quantity (b) Scalar quantity (c) Neither scalar nor vector quantity (d) None of these
- An arc of length equal to the circumference of a circle subtends an angle?  
(a)  $\pi$  radian (b)  $\pi/2$  radian (c)  $2\pi$  radian (d)  $4\pi$  radian
- Which is the following is not a unit of angular displacement:  
(a) Degree (b) Meters (c) Revolution (d) Radian
- One radian means  
(a) Arc length of unit radius is half (b) Arc length of unit radius is unity (c) One degree (d) All of these
- When an object moves on a circular path, then:  
(a) Its displacement is constant. (b) Its displacement changes due to change in distance (c) Its displacement changes due to change in direction of motion (d) Its displacement is always zero

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	b	b	c	c	a	c	b	d	b	a	c	b	b	c

- What force provides the centripetal force to planets moving around the sun?  
(a) Coulomb force (b) Gravitational force (c) Magnetic force (d) None of these
- If  $r = 1\text{m}$  and  $\theta = 1^\circ$  then what is the value of  $S$   
(a) 0.01745m (b) 1m (c) 2m (d) None
- A force which acts on an object moving in a circle and is directed towards the center of the circle is called  
(a) Bending force (b) Centripetal force (c) Centrifugal force (d) Normal force
- The angular displacement of an object after one complete revolution is:  
(a) Zero (b)  $\pi$  rad (c)  $2\pi$  rad (d)  $\frac{\pi}{3}$  rad
- Angular velocity of hour-hand of a mechanical watch is:  
(a) 2rev/day (b)  $\pi$  rad/6h (c) 1 rev/12h (d) All
- A particle moves in a circle of radius 25cm at two revolutions per second. The acceleration of particle in  $\text{m/s}^2$  is:  
(a)  $2\pi^2$  (b)  $4\pi^2$  (c)  $8\pi^2$  (d)  $\pi^2$
- A 500kg car takes a round turn of radius 50m with a velocity 36 km/h. The centripetal force is:  
(a) 1000N (b) 1200N (c) 750N (d) 250N
- The magnitude of centripetal force acting on a body of mass  $m$  executing uniform motion in a circle of radius  $r$  with speed  $v$  is:  
(a)  $v/r^2 m$  (b)  $mv^2/r$  (c)  $v/rm$  (d)  $Mvr$
- Angular displacement covered by minute hand in 20 minutes is:  
(a)  $\pi/2$  rad (b)  $\pi/3$  rad (c)  $\pi/6$  rad (d)  $2\pi/3$  rad
- A body moves with constant angular velocity on a circle. Magnitude of angular acceleration:  
(a)  $R\omega$  (b) Zero (c)  $R\omega^2$  (d)  $\frac{\omega^2}{R}$
- A particle is moving in a circle of radius  $R$  with constant speed  $v$ . If radius is double then its centripetal force to keep the same speed should be:  
(a) Unchanged (b) Halved (c) Doubled (d) Quadrupled
- Two bodies of mass 10kg and 5 kg moving in concentric orbits of radii  $R$  and  $r$  such that their periods are same. Then the ratio between their centripetal acceleration is:  
(a)  $R/r$  (b)  $r^2/r^2$  (c)  $r/R$  (d)  $R^2/r^2$
- The ratio of angular speeds of minute hand and hour hand of watch is:  
(a) 12:1 (b) 6:1 (c) 1:6 (d) 1:12
- A cyclist turns around a curve at 10Km/h. If he turns at double the speed, the tendency to overturn is:  
(a) Unchanged (b) Quadrupled (c) Halved (d) Doubled
- A stone of mass  $m$  is tied to a string of length  $L$  and rotated in a circle with a constant speed  $v$ . If the string is released, the stone flies:  
(a) With an acceleration  $\frac{mv^2}{L}$  (b) Tangentially outward (c) Radially outward (d) Radially inward
- The angular speed of a fly wheel making 120 revolutions/minute in radian per second is:  
(a)  $\pi$  rad/sec (b)  $2\pi$  rad/sec (c)  $4\pi$  rad/sec (d)  $4\pi^2$  rad/sec
- A particle revolves around a circular path with uniform speed. The acceleration of the particle is:  
(a) Zero (b) Along the tangent (c) Along the circumference of the circle (d) Along the radius

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
Ans:	b	a	b	c	d	b	a	b	d	b	b	a	a	b	b	c	d

32. If a particle moves in a circle describing equal angles in equal times, its velocity vector;  
 (a) Changes in direction (b) Changes in magnitude  
 (c) Changes both in magnitude and direction (d) Remains constant
33. The force required to move a body of mass 1kg with velocity 10m/s along circular path of radius 0.1m:  
 (a) 100N (b) 1N (c) 1000N (d) Zero
34. A body moves from one end of diameter to other end. If radius of circle is 1m then its angular displacement will be:  
 (a)  $\frac{\pi}{4}$  rad (b)  $\frac{\pi}{2}$  rad (c)  $\pi$  rad (d)  $2\pi$  rad
35. If a grid rod pivoted at point O is rotating around its own axis as shown in the figure below, then which point is moving faster
- 
- (a) A (b) B (c) C (d) All have same speed
36. If a tyre of radius 0.5m is rolling without slipping then its horizontal covered in 3 revolution is about:  
 (a) 5.4m (b) 9.4m (c) 14.4m (d) 20m
37. Angular speed of daily rotation of earth is:  
 (a)  $\pi/24$  rad/h (b)  $\pi/6$  rad/h (c)  $\pi/2$  rad/h (d)  $\pi/12$  rad/h
38. A body moving along a circular path completes a round trip. The angular displacement is:  
 (a)  $2\pi$  (b)  $2r$  (c) Zero (d)  $2\pi r$
39. A stone tied to the end of 20cm long string is whirled in a horizontal circle. If the centripetal acceleration is  $9.8\text{m/sec}^2$ , its angular speed in rad/s is:  
 (a) 14 (b)  $22/7$  (c) 20 (d) 7
40. If mass, speed and radius of circular path are doubled then required centripetal force will become:  
 (a) Double (b) Four times (c) Eight times (d) Sixteen times
41. A particle is moving in circular path of radius  $1/\pi$  m with time period 2s, then its rate of change of velocity will be:  
 (a)  $\pi \text{ m/s}^2$  (b)  $2\pi \text{ m/s}^2$  (c)  $\pi/2 \text{ m/s}^2$  (d)  $\pi/4 \text{ m/s}^2$
42. A particle of mass m is moving in a circular path of radius r then the graph between speed and required centripetal force is:



43. If angular frequency is doubled, centripetal force is  
 (a) Twice (b) Four times (c) Eight times (d) Remain same
44. The angular velocity will become equal to linear velocity when r becomes  
 (a) Zero (b) Very very small (c) Unity (d) Very very large

Sr.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.
Ans:	a	c	c	c	b	d	a	d	b	a	b	b	c

45. The frequency of a particle performing circular motion changes from 60 rpm to 180 rpm in 20s, then the angular acceleration is  
 (a)  $0.1\pi/\text{rad/s}^2$  (b)  $12\pi \text{ rad/s}^2$  (c)  $3\pi \text{ rad/s}^2$  (d)  $40\pi \text{ rad/s}^2$
46. A car is moving in a circular track of radius 20m at a constant speed of 20m/sec. Find the centripetal acceleration:  
 (a)  $20 \text{ m/s}^2$  (b)  $40 \text{ m/s}^2$  (c)  $30 \text{ m/s}^2$  (d)  $10 \text{ m/s}^2$
47. Circular motion of a particle while attached to a string centripetal acceleration is provided by:  
 (a) Tension in string (b) Gravitational force  
 (c) Normal force (d) None of these
48. Determine the angular displacement in radians of 6.5 revolutions:  
 (a) 40.8 radians (b) 4 radians (c) 3 radians (d) 36 radians
49. Find angular acceleration when  $\Delta\omega$  is 250 rpm and  $\Delta t$  is 5.00 s:  
 (a)  $5.24 \text{ rad/sec}^2$  (b)  $6 \text{ rad/sec}^2$  (c)  $10 \text{ rad/sec}^2$  (d) None of these
50. Determine the linear velocity of a point rotating at an angular velocity of  $12\pi$  radians per second at a distance of 8 centimeters from the center of the rotating object:  
 (a) 31.6 cm/s (b) 301.6 cm/s (c) 30.6 cm/s (d) 3016 cm/s

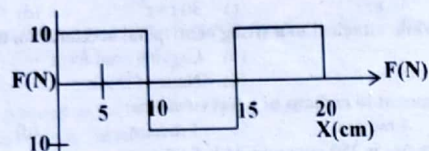
Sr.	45.	46.	47.	48.	49.	50.
Ans:	b	a	a	a	a	b

## PRACTICE TEST NO. 2

1. Angular speed of minutes hand of mechanical watch is:  
 (a)  $\frac{\pi}{30} \text{ radm}^{-1}$  (b)  $\frac{\pi}{2} \text{ radm}^{-1}$  (c)  $\frac{\pi}{12} \text{ radm}^{-1}$  (d)  $\pi \text{ radm}^{-1}$
2. Two bodies of equal masses are moving on two circular paths of radii in ratio 1:2, with same angular velocity. The ratio of centripetal forces acting on these bodies is:  
 (a) 4:1 (b) 2:1 (c) 1:4 (d) 1:2
3. Two cars of masses of  $m_1$  and  $m_2$  are moving along the circular path of radius  $r_1$  and  $r_2$ . They take one round in the same time. The ratio of angular velocity of two cars will be:  
 (a)  $m_1:m_2$  (b)  $m_1r_1:m_2r_2$  (c) 1:1 (d)  $r_1:r_2$
4. If two bodies having moment of inertia  $10\text{kgm}^2$  and  $20\text{kgm}^2$ . If they are subjected to same amount of torque then the ratio between their angular acceleration will be:  
 (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1
5. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion takes place in a plane. It follows that:  
 (a) Its velocity is constant (b) It moves in a circular path  
 (c) Its K.E is constant (d) Both B and C
6. The centripetal force required to keep the body in circular path is  $F_1$ . What would be centripetal force if radius becomes two times keeping same angular velocity:  
 (a)  $2F_1$  (b)  $F_1/4$  (c)  $4F_1$  (d)  $F_1/2$
7. A particle moving in a circular path may have:  
 (a) Tangential acceleration (b) Angular acceleration  
 (c) Radial acceleration (d) All of these
8. If a particle of mass m is moving in a circular path of radius r with time period T then the expression for required centripetal force will be:  
 (a)  $\frac{4\pi^2mr}{T^2}$  (b)  $\frac{4\pi^2mT^2}{r}$  (c)  $\frac{4\pi^2mT}{r}$  (d)  $\frac{4\pi^2mT}{r}$

Sr.	1	2	3	4	5	6	7	8
Ans:	a	d	c	b	d	a	d	a

9. A fan is switched off and its completes 20 revolutions before coming to rest, with uniform angular acceleration  $-10\text{ rev/s}^2$  then its initial angular velocity is:  
 (a)  $10\pi\text{ rad/s}$  (b)  $20\pi\text{ rad/s}$  (c)  $30\pi\text{ rad/s}$  (d)  $40\pi\text{ rad/s}$
10. The figure shows the force distance graph of a body moving along a straight line. The work done will be:



- (a) 100J (b) -100J (c) 200J (d) 50J
11. If the body is moving in a circle of radius  $r$  with constant speed  $v$ , its angular velocity:  
 (a)  $v^2/r$  (b)  $r/v$  (c)  $vr$  (d)  $v/r$
12. When body moves with a constant speed along a circle:  
 (a) Its velocity remains constant (b) No work is done on it  
 (c) No force acts on the body (d) No acceleration is produced in the body
13. A particle is moving in a horizontal circle with constant speed. It has constant:  
 (a) K.E (b) Displacement (c) Acceleration (d) Velocity
14. A particle moves with constant angular velocity in a circle. During the motion its:  
 (a) Momentum is conserved (b) Energy is conserved  
 (c) Both momentum and energy are conserved (d) None of the above is conserved
15. Direction of angular acceleration is always along the direction of:  
 (a) Velocity (b) Displacement (c) Force (d) Torque
16. A car moving on a horizontal road may be thrown out of the road in taking a turn:  
 (a) Due to the reaction of the ground (b) Due to rolling friction force between tyre and road  
 (c) By the gravitational force (d) Due to lack of sufficient centripetal force
17. A body is moving in a circular path with a constant speed. It has:  
 (a) A constant momentum (b) A constant velocity  
 (c) A constant acceleration (d) An acceleration of constant magnitude
18. Certain neutron stars are believed to be rotating at about  $1\text{ rev/sec}$ . If such a star has radius of  $20\text{ km}$ , the acceleration of an object on the equator of the star will be:  
 (a)  $120 \times 10^5\text{ m/sec}^2$  (b)  $8 \times 10^5\text{ m/sec}^2$  (c)  $20 \times 10^8\text{ m/sec}^2$  (d)  $4 \times 10^8\text{ m/sec}^2$
19. In uniform circular motion, the velocity vector and acceleration vector are:  
 (a) Not related to each other (b) Same direction  
 (c) Opposite direction (d) Perpendicular to each other
20. If a particle covers half the circle of radius  $R$  with constant speed then:  
 (a) Change in K.E is zero (b) Change in K.E is  $mv$   
 (c) Change in K.E is  $\frac{1}{2}mv$  (d) Momentum change is  $mvr$
21. A body of mass  $5\text{ kg}$  is moving in a circle of radius  $1\text{ m}$  with angular velocity of  $2\text{ radian/sec}$ . The centripetal force is:  
 (a)  $40\text{ N}$  (b)  $20\text{ N}$  (c)  $30\text{ N}$  (d)  $10\text{ N}$
22. The angular speed of seconds needle in a mechanical watch is:  
 (a)  $\frac{\pi}{30}\text{ rads}^{-1}$  (b)  $\frac{\pi}{60}\text{ rads}^{-1}$  (c)  $\pi\text{ rads}^{-1}$  (d)  $2\pi\text{ rads}^{-1}$

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	b	a	d	b	a	b	d	d	d	b	d	a	b	a

23. A particle of mass  $m$  is executing uniform circular motion on a path of radius  $r$ . If  $p$  is the magnitude of its linear momentum. The radial force acting on the particle is:  
 (a)  $Pmr$  (b)  $rm/p$  (c)  $mp^2/r$  (d)  $p^2/rm$
24. A particle moves with constant angular velocity in circular path of certain radius and is acted upon by a certain centripetal force  $F$ . If the angular velocity is doubled, keeping radius same, the new force will be:  
 (a)  $F/2$  (b)  $2F$  (c)  $4F$  (d)  $F^2$
25. SI unit of angular displacement is:  
 (a) Degree (b) Revolution (c) Radian (d) All of these
26. If a rotating body is moving anti-clockwise, the direction of angular velocity is:  
 (a) Towards the centre (b) Along the linear velocity  
 (c) Away from the center (d) Perpendicular to both radius and linear velocity
27. One rpm is equal to..... rad/sec:  
 (a) 2 (b) 1.5 (c) 2.5 (d) 0.105
28. When a body moves in a circle, the angle between its linear velocity and angular velocity is always?  
 (a) 180 (b) 0 (c) 90 (d) 45
29. The centripetal force is zero when centrifugal force is  
 (a) Minimum (b) Zero (c) Maximum (d) Infinity
30. An angular velocity of 60 revolutions per minute is the same as:  
 (a)  $\pi\text{ rad/s}$  (b)  $2\pi\text{ rad/s}$  (c)  $4\pi\text{ rad/s}$  (d)  $360^\circ\text{ degree s}^{-1}$
31. 7 Radian is equal to \_\_\_\_\_ degree approximately:  
 (a) 300 (b) 500 (c) 400 (d) None of these
32. The ratio of angular speed of the minute hand of clock to that of its hour hand is:  
 (a) 3600 : 1 (b) 24 : 1 (c) 60 : 1 (d) 12 : 1
33. The dimensions of angular velocity are:  
 (a)  $[LT^{-1}]$  (b)  $[LT^{-2}]$  (c)  $[LT]$  (d)  $[T^{-1}]$
34. What is the measure in radians of the angle  $A = 330^\circ$ ?  
 (a)  $11\pi/3$  (b)  $7\pi/4$  (c)  $7\pi/6$  (d)  $11\pi/6$
35. A mixture grinder rotates clockwise with constant angular velocity  $50\text{ rad/s}$  its angular acceleration will be:  
 (a) Zero (b) Negative (c) Uniform but not zero (d) Positive
36. The angular speed of the wheels of a bicycle is  $8\pi\text{ radian/sec}$  there period of rotation is:  
 (a) 25 sec (b) 4 sec (c)  $1/4\text{ sec}$  (d) 2 sec
37. The units of angular velocity are similar to:  
 (a) Angular displacement (b) Angular acceleration  
 (c) Angular frequency (d) None of these
38. Centrifugal acceleration of a car moving around in a circle of radius  $5\text{ m}$  with  $10\text{ m/s}$  velocity:  
 (a)  $20\text{ m/s}^2$  (b)  $10\text{ m/s}^2$  (c)  $6\text{ m/s}^2$  (d)  $11\text{ m/s}^2$
39. A car is moving in a circular track of diameter  $100\text{ m}$  at a constant speed of  $40\text{ m/sec}$ . Find the centripetal acceleration?  
 (a)  $42\text{ m/s}^2$  (b)  $52\text{ m/s}^2$  (c)  $32\text{ m/s}^2$  (d)  $30\text{ m/s}^2$
40. A body is moving in a circle of constant speed. Which statement is true?  
 (a) The resultant force acts towards the centre of the circle  
 (b) Resultant force is zero  
 (c) Resultant force is along the tangent  
 (d) Resultant force remains constant

Sr.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	d	c	c	d	d	c	c	c	c	d	d	d	a	c	c	a	c	a

41. The maximum velocity of SHM is  $v_0$  the period of oscillation is  
(a)  $2\pi x_0/v_0$  (b)  $2\pi v_0/x_0$  (c)  $2\pi v_0 x_0$  (d)  $2\pi/v_0 x_0$
42. If angular velocity increases the \_\_\_\_\_ also increases  
(a) Time period (b) Frequency (c) Velocity (d) Acceleration
43. Which of the following as a spin motion:  
(a) The motion of the planets round the sun  
(b) The motion of electron around the nucleus  
(c) The motion of the moon round the Earth  
(d) The daily rotation of Earth causing day and night
44. When brakes of a car are applied, angular velocity of a flywheel reduces from 900 cycles/min to 720 cycle/min in 6 sec. Angular retardation is  
(a)  $\pi \text{ rads}^{-2}$  (b)  $9\pi \text{ rad/s}^2$  (c)  $8\pi \text{ rad/s}^2$  (d) None of these
45. The rate of change of angular velocity is called:  
(a) Angular displacement (b) Angular acceleration  
(c) Angular velocity (d) Acceleration
46. A body performing circular motion with a constant speed has a constant:  
(a) Momentum (b) Angular velocity  
(c) Acceleration (d) Radius vector
47. One radian is equal to:  
(a) 57.3 degrees (b) 47.3 degrees (c) 67.5 degrees (d) 59.5 degrees
48. An object moving in a circle is tied to a string. What happens when the string is cut?  
(a) It continues moving in a circle (b) It flies off along a tangent  
(c) It falls straight down (d) None of these
49. The angle subtended at the center of a circle by an arc equal to the radius of the circle is:  
(a) One degree (b) One rotation (c) One radian (d) None of these
50. The relation between linear and angular velocity is:  
(a)  $\vec{v} = \vec{r} \times \vec{\omega}$  (b)  $\vec{v} = \vec{\omega} \times \vec{r}$  (c)  $\vec{\omega} = \vec{v} \times \vec{r}$  (d)  $\vec{r} = \vec{v} \times \vec{\omega}$
51. An electric fan rotating at 3 rev s<sup>-1</sup> is switched off. It comes to rest in 18.0 s. Assuming deceleration to be uniform. How many revolutions did it turn before coming to rest?  
(a) 30 rev (b) 27 rev (c) 40 rev (d) 10 rev

Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	b	a	b	b	a	b	c	c	b

## UNIT 04 &gt;&gt;

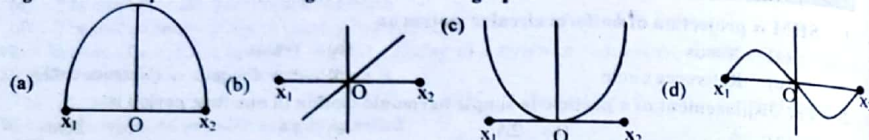
## OSCILLATIONS &amp; WAVES

## PRACTICE TEST NO. 1

1. SHM is projection of uniform circular motion on  
(a) X-axis (b) Y-axis  
(c) Reference circle (d) Any diameter of reference circle
2. The displacement of a particle in simple harmonic motion in one time period is:  
(a) A (b) 2A (c) 4A (d) Zero
3. A particle of mass  $m$  is hanging vertically by an ideal spring of force constant  $k$ . If the mass is made to oscillate vertically, its total energy is:  
(a) Maximum at extreme position  
(b) Maximum at mean position  
(c) Minimum at mean position  
(d) Same at all position
4. If the magnitude of displacement is numerically equal to that of acceleration, then the time period is:  
(a) 1 second (b)  $\pi$  second (c)  $2\pi$  second (d)  $4\pi$  second
5. A simple pendulum, executing SHM is falling freely along with the support. Then  
(a) It does not oscillate at all.  
(b) Its periodic time decreases.  
(c) Neither (a) nor (b)  
(d) Its periodic time increases.
6. If the mass of an oscillator is numerically equal to its force constant, then the frequency is:  
(a)  $\pi$  (b)  $2\pi$  (c)  $\frac{1}{\pi}$  (d)  $\frac{1}{2\pi}$
7. The P.E energy of a simple harmonic oscillator when the particle is half way to its end point is:  
(a)  $\frac{2}{3}E$  (b)  $\frac{1}{8}E$  (c)  $\frac{1}{4}E$  (d)  $\frac{1}{2}E$
8. What fraction of the total energy is potential when the displacement is one-half of the amplitude?  
(a)  $\frac{1}{4}$  (b)  $\frac{2}{4}$  (c)  $\frac{3}{4}$  (d)  $\frac{3.5}{4}$
9. A pendulum clock that keeps correct time on the Earth is taken to the Moon. It will run:  
(a) at correct rate (b) 6 times faster (c)  $\sqrt{6}$  times faster (d)  $\sqrt{6}$  times slower
10. Maximum velocity and maximum displacement for SHM are numerically equal when time period is:  
(a)  $\pi/2$  (b)  $\pi$  (c)  $2\pi$  (d) One

Sr.	1	2	3	4	5	6	7	8	9	10
Ans:	d	d	d	c	a	d	c	a	d	c

11. A particle is moving in a circle with uniform speed. Its motion is:  
 (a) Periodic and simple harmonic (b) Periodic but not simple harmonic  
 (c) Periodic (d) None of the above
12. The velocity of a particle performing simple harmonic motion, when it passes through its mean position is:  
 (a) Infinity (b) Zero (c) Minimum (d) Maximum
13. A particle of mass  $m$  oscillates with S.H.M between points  $x_1$  and  $x_2$  the equilibrium position being  $O$ . Its P.E is plotted. It will be given below in the graph:



14. In simple harmonic motion, the ratio of acceleration of the particle to its displacement at any time is a measure of:

(a) Spring constant (b) Angular frequency (c) (angular frequency)<sup>2</sup> (d) Restoring force

15. The P.E of a particle executing S.H.M is 25 J, at the displacement half of amplitude. The total energy of the particle will be:

(a) 18 J (b) 10 J (c) 100 J (d) 2.5 J

16. A particle moves such that its acceleration  $a$  is given by  $a = -bx$  where  $x$  is the displacement from equilibrium position and  $b$  is a constant. The period of oscillation is:

(a)  $2\pi\sqrt{b}$  (b)  $\frac{2\pi}{\sqrt{b}}$  (c)  $\frac{\sqrt{b}}{2\pi}$  (d)  $2\sqrt{\pi/b}$

17. A simple pendulum executing S.H.M is falling freely along with the support. Then

(a) Its periodic time decrease (b) Its periodic time increase  
 (c) It does not oscillate at all (d) None

18. The length of second pendulum on the surface of earth is about:

(a) 99.8 m (b) 99 cm (c) 100 m (d) None of these

19. A spring having a spring constant  $k$  is loaded with a mass  $m$ . The spring is cut into two equal parts and one this is loaded again with the same mass. The new spring constant is:

(a)  $K/2$  (b)  $k$  (c)  $2k$  (d)  $K^2$

20. The relation between frequency ' $n$ ' wavelength ' $\lambda$ ' and velocity of propagation ' $v$ ' of wave is:

(a)  $n = v\lambda$  (b)  $n = \lambda/v$  (c)  $n = v/\lambda$  (d)  $n = 1/v$

21. If velocity of sound in gas is 360 m/s and the distance between compression and nearest rarefaction is 1m, then the frequency of sound is:

(a) 90 Hz (b) 180 Hz (c) 360 Hz (d) 720 Hz

22. Speed of sound at constant temperature depends on:

(a) Pressure of gas (b) Density of gas (c) Frequency of wave (d) Wavelength of wave

23. It is possible to distinguish between the transverse and longitudinal wave by studying the property of:

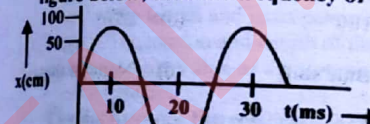
(a) Interference (b) Diffraction (c) Reflection (d) Polarization

24. Mechanical waves on the surface of liquid are:

(a) Transverse (b) Longitudinal  
 (c) Torsional (d) Both transverse and longitudinal

Sr.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Ans.	b	d	c	c	c	b	c	b	c	c	b	b	d	a

25. If the ratio of amplitude of two waves is 2:1, then the ratio of maximum and minimum intensity, when waves interfere with each other is:  
 (a) 9:1 (b) 1:9 (c) 4:1 (d) 2:1
26. The distance between the nearest node and anti node in a stationary wave is:  
 (a)  $\lambda$  (b)  $\lambda/2$  (c)  $\lambda/4$  (d)  $2\lambda$
27. A 1 cm long string vibrates with fundamental frequency of 256 Hz. If the length is reduced to  $\frac{1}{4}$  cm keeping the tension unaltered, the new fundamental frequency will be:  
 (a) 64 Hz (b) 200 Hz (c) 300 Hz (d) 400 Hz
28. Length of a string tied to two rigid supports is 40 cm. Maximum wavelength of a stationary wave produced in it is:  
 (a) 20 cm (b) 80 cm (c) 40 cm (d) 120 cm
29. If the temperature increases, then what happens to the frequency of the sound waves produced in the organ pipe:  
 (a) Increases (b) Decreases (c) Unchanged (d) Not definite
30. Which of the following quantity does not change when wave change its medium:  
 (a) Speed (b) Frequency (c) Wavelength (d) All of these
31. The graph between displacement of medium particles for a transverse wave is shown in the figure below, then the frequency of wave will be:

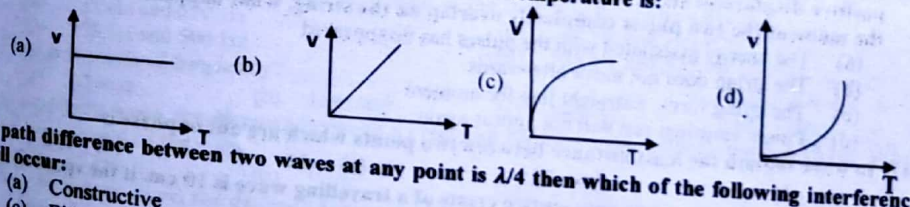


(a) 5 Hz (b) 50 Hz (c) 20 Hz (d) 200 Hz

32. Speed of sound in vacuum is:

(a) 332 m/s (b) 340 m/s (c) 350 m/s (d) Zero

33. The graph between speed of sound in air and absolute temperature is:



34. If path difference between two waves at any point is  $\lambda/4$  then which of the following interference will occur:  
 (a) Constructive (b) Destructive  
 (c) Either constructive or destructive (d) Neither constructive nor destructive

35. If frequency of fundamental harmonic is increased by 100% then percentage increase in tension will be:  
 (a) 100% (b) 200% (c) 300% (d) 400%

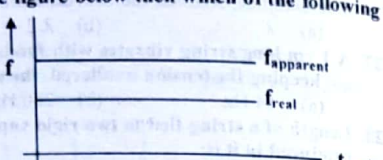
36. Standing waves are produced in a 10 m long stretched string. If the string vibrates in 5 segments and the wave velocity is 20 m/s, the frequency is:

(a) 2 Hz (b) 4 Hz (c) 5 Hz (d) 10 Hz

37. In a closed organ pipe of frequency of fundamental note is 50 Hz. The note of which of the following frequencies will not be emitted by it:

(a) 50 Hz (b) 100 Hz (c) 150 Hz (d) None of these

Sr.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
Ans.	a	c	a	b	a	b	b	d	c	d	c	b	b

38. What should be the velocity of an observer moving towards a stationary source so that apparent frequency is double the actual frequency  
(a)  $v$  (b)  $v/2$  (c)  $2v$  (d)  $v/4$
39. The graph between frequency and time is shown in the figure below then which of the following statement is correct
- 
- (a) Source is moving away from observer  
(b) Observer is moving away from source  
(c) Source and observer are moving towards each other  
(d) Source and observer are moving away from each other
40. Beats can be used to find:  
(a) Speed (b) Frequency (c) Amplitude (d) Wavelength
41. The shortest distance between two points on the wave that have a phase difference of  $(\frac{\pi}{3})$  is 5 cm. What is its wavelength  
(a) 10 cm (b) 20 cm (c) 30 cm (d) 40 cm
42. An air pipe opens at both ends. A stationary wave is produced in second harmonic mode. What is the phase difference between the motion of the particles at the end of the pipe and at the centre of the pipe.  
(a)  $0^\circ$  (b)  $90^\circ$  (c)  $180^\circ$  (d)  $270^\circ$
43. A star moving away from earth shows  
(a) Green shift (b) Red shift (c) Blue shift (d) None of these
44. The speed of sound in a metal is approximately:  
(a) 1500 m/s (b) 5000 m/s (c) 330 m/s (d) 50 m/s
45. A container is filled with oxygen and helium at the same temperature. The molar mass of oxygen is 32 g/mol and that of helium is 4 g/mol. What is the ratio: average speed of sound in oxygen to a speed in helium?  
(a)  $1 : \sqrt{8}$  (b)  $\sqrt{8} : 1$  (c)  $1 : 8$  (d)  $8 : 1$
46. Two pulses move in opposite direction on a string and are identical in shape except that one has positive displacements of the elements of the string and the other has negative displacements. At the moment the two pulses completely overlap on the string, what happens?  
(a) The energy associated with the pulses has disappeared  
(b) The string does not move afterwards  
(c) The string forms a straight line for moment  
(d) Pulses vanished and will not appear again
47. In wave motion the least distance between two points which are out of phase is  
(a)  $\lambda$  (b)  $3\lambda$  (c)  $4\lambda$  (d)  $\lambda/2$
48. The distance between two consecutive crests of a travelling wave is 10 cm. if the speed of the wave 50 cm/s, then its frequency will be:  
(a) 40 Hz (b) 1/5 Hz (c) 5 Hz (d) 500 Hz
49. Two tuning forks produces  $N$  beats. If one of these tuning forks has the frequency  $f$ , then the frequency of the other would be  
(a)  $N - f$  (b)  $N/f$  (c)  $N + f$  (d) Both a and c
50. A sound wave travels from a region of hot air into a region of cold air. How does frequency and wavelength of sound change?  
(a) Frequency decrease wavelength decrease  
(b) Frequency increase wavelength decrease  
(c) Frequency does not change wavelength decrease  
(d) Frequency does not change wavelength does not change

Sr.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	c	b	c	c	b	b	a	c	d	c	d	c

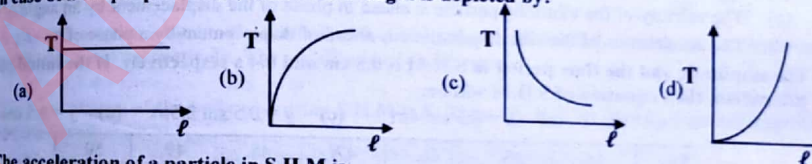
1. The waves which propagate by the oscillation of material particles are called:  
(a) Matter waves (b) Mechanical waves  
(c) Electromagnetic waves (d) Microwaves
2. The frequency of a string on a musical instrument can be changed either by:  
(a) Varying the diameter or by changing the length  
(b) Varying the tension or by changing the thickness  
(c) Varying the tension or by changing the length  
(d) All of these
3. The speed of sound in air is approximately:  
(a) 1500 m/s (b) 5000 m/s (c) 330 m/s (d) 50 m/s
4. Wavelength of a sound wave in air is 10cm, what is the frequency of the sound wave?  
(a) 33 Hz (b) 330 Hz (c) 3300 Hz (d) 33000 Hz
5. The stationary waves can be set up on the string only with the frequencies of harmonic series determined by  
(a) The tension, length and mass per unit length of the string  
(b) The tension and mass per unit length of the string only  
(c) The length and mass per unit length of the string only  
(d) The tension and length of the string only
6. The maximum value of displacement from the mean position is called  
(a) Height (b) Amplitude (c) Frequency (d) Distance
7. The direction of the restoring force is always towards:  
(a) Right hand (b) Up ward  
(c) Rest or mean position (d) Extreme position
8. A stationary wave is formed in a pipe which is open at one end. If length of pipe is 5cm, then what is the maximum possible wavelength of the wave?  
(a) 5cm (b) 10 cm (c) 15 cm (d) 20 cm
9. A pipe is filled with a gas and open at one end. If the length of the pipe is 0.6 m and the speed of sound in the gas is 300 m/s. Then frequencies of the first two harmonics are:  
(a) 125 Hz and 250 Hz (b) 250 Hz and 750 Hz  
(c) 250 Hz and 500 Hz (d) 125 Hz and 375 Hz
10. What is the unit of frequency?  
(a) 1/Hertz (b) 1/second<sup>2</sup> (c) Second (d) Hertz
11. In a periodic wave, the distance between a crest and the next consecutive trough is 15 cm. What is the wavelength of the wave?  
(a) 10 cm (b) 5 cm (c) 7.5 cm (d) 30 cm
12. In a stationary wave, the distance between adjacent antinodes is equal to:  
(a)  $\lambda$  (b)  $2\lambda$  (c)  $\lambda/2$  (d)  $\lambda/4$
13. Which of the following phenomenon proves that light waves are transverse  
(a) Polarization (b) Refraction (c) Interference (d) None of these
14. A stationary wave is setup on a string of length 10 cm. four loops are formed. What is the distance between two consecutive crests?  
(a) 4.5 cm (b) 5 cm (c) 2.5 cm (d) 1.25 cm
15. The oscillating object overshoots the rest position due to  
(a) Restoring force (b) Inertia (c) Gravitational potential energy (d) Elastic potential energy

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Ans:	b	d	c	c	a	b	c	d	d	d	d	c	a	b	b

16. When a standing wave is set up on a string fixed at both ends, which of the following statements is true?
- Sum of the number of antinodes and the number of nodes is always even
  - Wavelength = length of string / number of nodes
  - The shape of the string at any instant shows a symmetry about the midpoint of the string
  - Frequency = number of nodes  $\times$  fundamental frequency
17. Stars are moving away from earth shows:
- Increase in wavelength
  - Increase in frequency
  - Decrease in wavelength
  - Increase in intensity
18. A source of sound is travelling towards a stationary observer. The frequency of sound heard by observer is of three times the original frequency. The velocity of sound is  $v$  m/sec. The speed of source will be:
- $\frac{2}{3}v$
  - $v$
  - $\frac{3}{2}v$
  - $3v$
19. A string of 7 m length has a mass of 0.035 kg. if tension in the string is 60.5 N, then speed of a wave on the string is:
- 77 m/s
  - 102 m/s
  - 110 m/s
  - 165 m/s
20. Speed of transverse waves in stretched string is given as  $v = \sqrt{F/m}$ , then the dimensions of 'm' are:
- $ML^0$
  - $MLT^0$
  - $ML^{-1}$
  - $ML^{-2}$
21. At what temperature the speed of sound will be double as that is at  $10^\circ\text{C}$ .
- $1132^\circ\text{C}$
  - $40^\circ\text{C}$
  - $1132\text{ K}$
  - $1032\text{ K}$
22. At constant pressure, if the density of air is reduced to one-fourth, the speed of sound will become:
- Double
  - Half
  - Four times
  - One fourth
23. Speed of sound in any medium is independent of:
- Compressibility of medium
  - Inertia of the medium
  - Frequency of the source
  - None of these
24. Velocity of sound in air is:
- Faster in dry air than in moist air
  - Directly proportional to pressure
  - Directly proportional to temperature
  - Independent of pressure of air
25. If fundamental frequency of closed pipe is 50 Hz then frequency of 2<sup>nd</sup> overtone is:
- 100 Hz
  - 50 Hz
  - 250 Hz
  - 150 Hz
26. If you set up the seventh harmonic on string fixed at both ends, how many nodes and anti-nodes are set up in it:
- 8, 7
  - 7, 7
  - 8, 9
  - 9, 8
27. In stationary waves all particles between two nodes pass through the mean position:
- At different times with different velocities
  - At different times with same velocity
  - At the same time with equal velocity
  - At the same time with different velocities
28. Beats are the result of:
- Diffraction
  - Destructive interference
  - Constructive and destructive interference
  - Superposition of two waves of slightly different frequencies
29. Sound waves of wavelength greater than that of audible sound are called:
- Seismic waves
  - Sonic waves
  - Ultrasonic waves
  - Infrasonic waves

Sr.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
Ans:	c	d	a	c	c	c	a	c	d	c	a	d	d	d

30. The velocity of sound is  $v$  in air. If the density of air is increased to 4 times at constant pressure, then the new velocity of sound will be:
- $v/2$
  - $v/\sqrt{2}$
  - $2v$
  - $v/4$
31. The phase difference between two points separated by 1m in a wave of frequency 120 Hz is  $90^\circ$ . The wave velocity is:
- 180 m/s
  - 240 m/s
  - 480 m/s
  - 720 m/s
32. A tuning fork makes 256 vibrations per second in air. When the velocity of sound is 330 m/s then the wavelength of the tone emitted is:
- 0.56 m
  - 1.11 m
  - 0.89 m
  - 1.29 m
33. A simple pendulum is taken from equator to the pole. Its period:
- Increase
  - Decrease
  - Remains same
  - Decrease then increase
34. If the length of simple pendulum is increased by 300%, then the time period will be increased by:
- 100 %
  - 200 %
  - 300 %
  - 400 %
35. The period of a simple pendulum is doubled when:
- Its length is doubled
  - The mass of bob is doubled
  - Its length is made four times
  - The mass of the bob and length of pendulum is doubled
36. When the displacement is half the amplitude, the ratio of P.E to the total energy is:
- $\frac{1}{2}$
  - 1
  - $\frac{1}{4}$
  - $\frac{1}{8}$
37. In case of a simple pendulum, time versus length is depicted by:



38. The acceleration of a particle in S.H.M is:
- Always zero
  - Always constant
  - Maximum at extreme position
  - Maximum at equilibrium position
39. The phase difference between its displacement and velocity is:
- $\pi/2$
  - $\pi$
  - $2\pi$
  - $3\pi$
40. A particle starts S.H.M from the mean position. Its amplitude is A and time period T. At the time when its speed is half of the maximum speed, its displacement y is:
- $A/2$
  - $A/\sqrt{2}$
  - $A\sqrt{3}/2$
  - $2A\sqrt{3}$
41. The maximum speed of a particle executing SHM is  $1\text{ ms}^{-1}$  and maximum acceleration is  $1.57\text{ ms}^{-2}$ . The time period is:
- 4 s
  - 0.25 s
  - 0.16 s
  - $\frac{1}{157}\text{ s}$
42. Which one of the following statement is true for the speed  $v$  and the acceleration  $a$  of a particle executing simple harmonic motion?
- Value of  $a$  is zero, whatever may be the value of  $v$ .
  - When  $v$  is zero,  $a$  is zero.
  - When  $v$  is maximum,  $a$  is zero.
  - When  $v$  is maximum,  $a$  is maximum.
43. Two springs have force constants in the ratio 4 : 9. Their time periods are in the ratio of:
- 3 : 2
  - 2 : 3
  - 1 : 3
  - 3 : 1

Sr.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	a	c	d	b	a	c	c	B	c	a	c	c	c	a

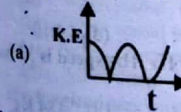
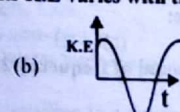
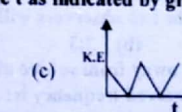
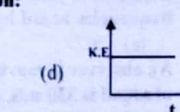
44. If the period of oscillation of mass  $M$  suspended from a spring is one second, then the period of mass  $4M$  will be  
 (a) 2 s (b)  $1/2$  s (c) 4 s (d)  $1/4$  s
45. Time period of oscillation of a spring is 12 s on Earth. What shall be the time period if it is taken to Moon?  
 (a) 12 s (b)  $\frac{12}{6}$  s  
 (c)  $12 \times 6$  s (d)  $16 \times \sqrt{12}$
46. For a simple pendulum, the graph between  $l$  and  $T$  is  
 (a) Hyperbola (b) Curved line (c) Straight line (d) Parabola
47. What is represented by  $\frac{1}{2} m x_0^2 \omega^2$ , where the letters have usual meanings?  
 (a) Maximum K.E. (b) Maximum P.E. (c) Total energy (d) All of these
48. What is effect on the time period of a simple pendulum if the length is quadrupled?  
 (a) Halved (b) Doubled (c) No effect (d) It would be zero
49. In simple harmonic motion,  
 (a) The velocity and displacement of the vibrating particle are in the same phase.  
 (b) The velocity and acceleration of the vibrating particle are in the same phase.  
 (c) The velocity of the vibrating particle is ahead in phase of the displacement by an angle of  $\pi$ .  
 (d) The acceleration of the vibrating particle is ahead of displacement by a phase of  $\pi$ .
50. The amplitude and the time period in S.H.M is 0.5 cm and 0.4 s respectively. If the initial phase is  $\pi/2$  radian, then equation of S.H.M will be:  
 (a)  $y = 0.5 \sin 5\pi t$  (b)  $y = 0.5 \sin 4\pi t$  (c)  $y = 0.5 \sin 2.5\pi t$  (d)  $y = 0.5 \cos 5\pi t$

Sr.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	a	d	d	a	d	d

## PRACTICE TEST NO. 3

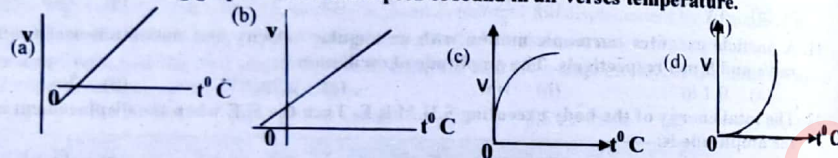
1. Given: equation of SHM is  $x = 10 \sin(20t + 0.5)$ . The initial phase is:  
 (a) 0.5 radian (b) 20 radian (c) 10 radian (d) None of these
2. A particle executes SHM. The graph of its velocity as a function of displacement is:  
 (a) a straight line (b) a circle (c) an ellipse (d) a hyperbola
3. A spring-mass system oscillates with a frequency  $f$ . If it is taken in an elevator slowly accelerating upward, the frequency will  
 (a) Increase (b) Decrease (c) Remain same (d) Become zero
4. A simple harmonic oscillator has a period of 0.01 s and an amplitude of 0.2 m. the magnitude of the velocity in  $\text{ms}^{-1}$  at the centre of oscillation is:  
 (a) 100 (b)  $100\pi$  (c)  $20\pi$  (d)  $40\pi$
5. The acceleration of a particle in simple harmonic motion is:  
 (a) Always zero (b) Always constant  
 (c) Maximum at the extreme position (d) Maximum at the equilibrium position

Sr.	1	2	3	4	5
Ans:	a	c	c	d	c

6. A body executes simple harmonic motion. The potential energy (P.E.), the kinetic energy (K.E.) and total energy (T.E.) are measured as a function of displacement  $x$ . Which of the following statements is true?  
 (a) P.E is maximum when  $x = 0$   
 (b) K.E is maximum when  $x = 0$   
 (c) T.E is zero when  $x = 0$   
 (d) K.E is maximum when  $x = \text{maximum}$
7. The maximum acceleration in a SHM is  $\alpha$  and the maximum velocity is  $\beta$ . The amplitude is:  
 (a)  $\frac{\beta^2}{\alpha}$  (b)  $\frac{\alpha}{\beta^2}$  (c)  $\alpha\beta$  (d)  $\frac{\beta}{\alpha}$
8. A particle executes an undamped SHM of time period  $T$ . Then the time period with the potential energy changes is:  
 (a)  $T$  (b)  $2T$  (c)  $T/2$  (d)  $T/4$
9. A system exhibiting S.H.M must possess:  
 (a) Inertia only (b) Restoring force as well as inertia  
 (c) Restoring force, inertia and external force (d) Restoring force only
10. Velocity at mean position of a particle executing S.H.M is  $v$ , they velocity of the particle at a distance equal to half of the amplitude:  
 (a)  $4v$  (b)  $\frac{\sqrt{3}}{2}v$  (c)  $2v$  (d)  $\frac{\sqrt{3}}{4}v$
11. A particle executes harmonic motion with an angular velocity and maximum acceleration of 2 rad/s and 8  $\text{m/s}^2$  respectively. The amplitude of oscillation is:  
 (a) 0.1 m (b) 1 m (c) 0.2 m (d) 2 m
12. The total energy of the body executing S.H.M is  $E$ . Then the K.E when the displacement is half of the amplitude is:  
 (a)  $E/2$  (b)  $3E/4$  (c)  $E/4$  (d)  $\sqrt{3}/4 E$
13. What is constant in S.H.M?  
 (a) Restoring force (b) Potential energy (c) Kinetic energy (d) Time period
14. If the metal bob of simple pendulum is replaced by a wooden bob, then its time period will:  
 (a) Increase (b) Decrease (c) Remain the same (d) First increase then decrease
15. The ratio of frequencies of two pendulum are 2:3, then their length are in ratio:  
 (a)  $\sqrt{2/3}$  (b)  $\sqrt{3/2}$  (c)  $4/9$  (d)  $9/4$
16. A body performs S.H.M. Its K.E varies with time  $t$  as indicated by graph:  
 (a)  (b)  (c)  (d) 
17. If the density of oxygen is 16 times to that of hydrogen, what will be the ratio of their corresponding velocities of sound waves:  
 (a) 1:4 (b) 4:1 (c) 16:1 (d) 1:16
18. The type of waves that can be propagated through solid is:  
 (a) Transverse (b) Longitudinal (c) Both a and b (d) None of these
19. What is the phase difference between two successive crest in a wave:  
 (a)  $\pi$  (b)  $2\pi$  (c)  $\pi/2$  (d)  $4\pi$

Sr.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
Ans:	b	b	c	b	b	d	b	d	c	d	a	a	b	b

20. The intensity ratio of two of two waves is 4:1, then the ratio of maximum and minimum intensity, when waves interfere with each other is:  
(a) 1:16 (b) 1:9 (c) 9:1 (d) 1:4
21. Which of the property makes difference between progressive and stationary waves;  
(a) Amplitude (b) Frequency (c) Propagation of energy (d) Phase of the wave
22. If number of vibrations of a string are to be increased by factor of two, then tension in the string must be made:  
(a) Half (b) 16 times (c) Two times (d) Four times
23. A pipe 30 cm long is open at both ends. Which harmonic mode of the pipe is resonantly excited by a 1.1 KHz source? ( $v = 330$  m/s).  
(a) First (b) Second (c) Third (d) Fourth
24. The Doppler's effect is applicable for:  
(a) Light waves (b) Sound waves (c) Radio waves (d) All of these
25. When sound wave enter from a rare medium to denser medium then which of the following statement is not true:  
(a) Speed increases (b) Wavelength increases (c) Frequency increases (d) All of these
26. With increase in humidity in air the speed of sound in air is:  
(a) Increase (b) Decrease (c) Remains same (d) Become zero
27. Which of the following graph is correct for speed of sound in air versus temperature.



28. If the distance between two consecutive nodes is one fourth of length ' $\ell$ ' of the string then the wavelength of the wave will be:  
(a)  $\ell$  (b)  $\ell/2$  (c)  $2\ell$  (d)  $8\ell$
29. A stretched string of length ' $\ell$ ', fixed at both ends can sustain stationary waves of wavelength  $\lambda$ , given by:  
(a)  $\lambda = n^2/n\ell$  (b)  $\lambda = \ell^2/2n$  (c)  $\lambda = 2\ell/n$  (d)  $\lambda = 2\ell n$
30. A source of sound emits wave with frequency  $f$  Hz and speed  $v$  m/sec. Two observers moves away from this source in opposite direction with a speed of  $0.2 v$  relative to the source. The ratio of frequencies heard by the two observers will be:  
(a) 3:2 (b) 2:3 (c) 1:1 (d) 4:10
31. An observer is moving away from source of sound of frequency 200 Hz. His speed is 33 m/s speed of sound is 330 m/s, observed frequency is:  
(a) 90 Hz (b) 180 Hz (c) 92 Hz (d) 184 Hz
32. Which of the following is not an assumption of the kinetic model of an ideal gas? unit 5  
(a) The size of the molecules is much smaller than the separation between molecules.  
(b) Molecules suffer negligible momentum change during wall collisions  
(c) Molecules do not exert force on each other except during a collision  
(d) The gas molecules are in random motion and may change their direction of motion after every collision

Sr.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.
Ans:	c	c	d	b	d	c	a	b	b	c	c	b	b

33. The phase angle between two points is  $3\pi$ . The distance between these points is 15 cm. What is the wavelength of the wave?  
(a) 30 cm (b) 45 cm (c) 5 cm (d) 10 cm
34. A wave passes through a medium, each particle of the medium performs 100 complete vibrations in 5 seconds. What is the frequency of the wave  
(a) 2 Hz (b) 20 Hz (c) 4 Hz (d) 40 Hz
35. In mass-spring system, which of the following does not depend on the initial displacement of the spring?  
(a) Maximum kinetic energy of the mass (b) Average speed of the mass (c) Total energy of the mass (d) Angular frequency of the oscillation
36. If the wavelength of a wave is 20 cm and its time period is  $T$ . What is the distance travelled by a crest of the wave in  $1.25T$ ?  
(a) 30 cm (b) 25 cm (c) 15 cm (d) 40 cm
37. An ambulance siren emits a sound of frequency 1800 Hz. The speed of sound in air is 330 m/s. The ambulance moves towards a stationary observer at a constant speed of 50 m/s. What is the frequency heard by the observer?  
(a)  $(1800 \times 290)/330$  (b)  $(1800 \times 330)/280$  (c)  $(1800 \times 330)/370$  (d)  $(1800 \times 330)/380$
38. A transverse wave on a string has an amplitude  $A$ . A tiny spot on the string is colored red. As one cycle of the wave passes by, what is the total distance traveled by the red spot?  
(a)  $A$  (b)  $2A$  (c)  $A/2$  (d)  $4A$
39. Superposition of two waves having slightly different frequency, same amplitude and travelling in the same direction, is called  
(a) Interference (b) Diffraction (c) Beats (d) Stationary waves
40. In a stationary wave, if the string is made to vibrate in  $n$  loops, the frequency of stationary waves set up on the string will be:  
(a)  $f_n = n \times f_1$  (b)  $f_n = n + f_1$  (c)  $F_n = f_1 / n$  (d)  $n \times f_n = f_1$
41. What is the duration of an cycle known as:  
(a) Period (b) Cycle (c) Instantaneous (d) Sin wave
42. A tuning fork A produces 4 beats with another tuning fork B. If the frequency of tuning fork B is 320 Hz, then the frequency of tuning fork A is:  
(a) 80 Hz (b) 1280 Hz (c) 324 Hz (d) 328 Hz
43. What is echo of sound?  
(a) When sound reflects back (b) When sound gets absorbed (c) When sound penetrates into objects (d) All of them
44. If a longitudinal wave travelling in a denser medium is incident on a rarer medium, it is..  
(a) Reflected without any change in phase (b) Reflected with phase change of 90 degree (c) Reflected with phase change of 180 degree (d) Reflected with phase change of 270 degree
45. A sound wave has a wavelength  $\lambda$ . What is the minimum possible distance between two points with phase difference 90 deg?  
(a)  $\lambda/4$  (b)  $3\lambda/2$  (c)  $5\lambda/2$  (d)  $5\lambda/4$

Sr.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.
Ans:	d	b	d	b	b	d	c	a	a	c	a	c	a

46. A stationary wave is formed in a pipe which is open at both ends. If two complete loops are formed and the wavelength of the wave is 10 cm, what is the length of the pipe?  
 (a) 15 cm (b) 10 cm (c) 5 cm (d) 20 cm
47. Which of the following statements is true?  
 (a) Power is proportional to voltage only  
 (b) Power is proportional to current only  
 (c) Power is neither proportional to voltage nor to the current  
 (d) Power is proportional to both the voltage and current
48. A stationary wave is setup on a string which is fixed at both ends. The frequency of the wave is 400 Hz. If the speed of wave is 480 m/s, then what is the length of the string?  
 (a) 1.2 m (b) 0.84 m (c) 0.60 m (d) 0.42 m
49. A succession of events which bring the system back to its initial condition is called:  
 (a) Oscillation (b) Vibration (c) Cycle (d) Circle
50. A spring having spring constant of 10 N/m<sup>2</sup> is stretched to 5 m, what will be the work done:  
 (a) 250 J (b) 50 J (c) -250J (d) 125 J

Sr.	46.	47.	48.	49.	50.
Ans:	b	d	c	c	d

## PRACTICE TEST NO. 4

1. The wavelength of matter wave is independent of:  
 (a) Mass (b) Velocity (c) Kinetic energy (d) Charge
2. The speed of sound,  $v$ , is not affected by a variation in the pressure of the gas, because:  
 (a) Speed,  $v$ , does not depend on pressure  
 (b) Speed,  $v$ , does not depend on density  
 (c) Density is proportional to pressure  
 (d) None of the above
3. Speed of the sound,  $v$ , in a medium of elastic modulus  $E$  and density  $d$ , is given by:  
 (a)  $v = E/d$  (b)  $v = E \times d$  (c)  $v^2 = E \times d$  (d)  $v^2 = E/d$
4. When path difference between two waves are integral multiple of wavelength, the resultant effect is called:  
 (a) Destructive interference  
 (b) Constructive interference  
 (c) Beats  
 (d) Diffraction
5. In case of harmonic oscillator total energy remains  
 (a) Variable (b) Infinity (c) Constant (d) Zero
6. A park has an outdoor organ. When the air temperature increase, the fundamental frequency of one of the organ pipes:  
 (a) Is impossible to determine (b) Remain the same  
 (c) Decrease (d) Increase
7. The shortest distance between two points on a travelling wave that have a phase difference of  $(\pi/3)$  is 5 cm. If the wave has frequency 500 Hz, what is the speed of the wave?  
 (a) 300 m/s (b) 150 m/s (c) 300 cm/s (d) 150 cm/s
8. Radar system is an application of:  
 (a) Doppler's effect (b) Compton's effect  
 (c) Resonance (d) Wave nature of matter

Sr.	1	2	3	4	5	6	7	8
Ans:	d	c	d	b	c	d	b	a

9. The distance between two consecutive nodes in a stationary wave is equal to:  
 (a) One wavelength (b) 2.5 wavelength  
 (c) 3 wavelength (d) Half wavelength
10. When a wave comes across the boundary of two media, a part of it is reflected back. Which statement is true about reflected wave:  
 (a) Its wavelength changes depending on the nature of the boundary  
 (b) Its frequency changes depending on the nature of the boundary  
 (c) Its amplitude increases depending on the nature of the boundary  
 (d) Its phase may changes depending on the nature of the boundary
11. A vibrating string have a little sound. However, when attached with a board then sound have a greater intensity. It is because:  
 (a) The string vibrates with more energy  
 (b) The sound is concentrated over smaller area  
 (c) The speed of sound is greater in board  
 (d) The energy leaves the board at a greater rate
12. The two points of a medium are separated through a distance of 10cm. What is the phase angle between these two points if the wavelength of the wave is 0.1m.  
 (a)  $\pi$  (b)  $2\pi$  (c)  $3\pi$  (d)  $3\pi/4$
13. When a standing wave is set up in a pipe which is open from one end, which of the following statement is true?  
 (a) Sum of the number of antinodes and the number of nodes is always even  
 (b) Wavelength = length string / number of nodes  
 (c) The shape of the string at any instant shows a symmetry about the midpoint of the string  
 (d) Frequency = number of nodes  $\times$  fundamental frequency
14. Frequency of a travelling wave is 2000 Hz. Its speed is 300 m/s. What is its wavelength?  
 (a) 20/3 m (b)  $20 \times 3$  m (c) 3/20 m (d) 2/3 m
15. The speed  $v$  of the waves in the string depends upon the tension  $F$  of the string and  $m$ , the mass per unit length of the string. It is given by  
 (a)  $v^2 = F/m$  (b)  $v = F/m$  (c)  $v \times m = F$  (d)  $v = F \times m$
16. At what speed should a source of sound move away from the source so that stationary observer finds the apparent frequency equal to half of the original frequency:  
 (a)  $v/2$  (b)  $2v$  (c)  $v/4$  (d)  $v$
17. The source is moving away from a stationary observer then the pitch of the sound will:  
 (a) Decrease (b) Increase (c) Remains same (d) Cannot be predicted
18. Doppler shift in frequencies does not depend upon:  
 (a) The frequency of the wave produced (b) The velocity of the source  
 (c) The velocity of the observer (d) None of the above
19. The fundamental frequency of a closed organ pipe is 100 Hz. The frequency of the second overtone is:  
 (a) 100 Hz (b) 200 Hz (c) 300 Hz (d) 500 Hz
20. If two waves having amplitude 2 cm and 3 cm interfere with each other then the ratio between maximum and minimum intensities will be:  
 (a) 3:2 (b) 5:1 (c) 25:1 (d) 1:25
21. Speed of sound at temperature 10°C is about:  
 (a) 332 m/s (b) 338 m/s (c) 342 m/s (d) 348 m/s
22. Speed of sound in air is 332 m/s at temperature:  
 (a) Zero kelvin (b) 273 k (c) 373 k (d) Room temperature

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	d	d	b	b	a	c	a	d	a	c	d	c	b	b

23. When frequency of sound is 400 Hz. The speed of sound in air is  $v$ . What is speed of sound in air if frequency is 800 Hz:  
 (a)  $v$  (b)  $v/2$  (c)  $2v$  (d)  $4v$
24. With which velocity an observer should move relative to a stationary source so that he hears a sound of double the frequency of source:  
 (a) Velocity of sound towards the source  
 (b) Velocity of sound away from the source  
 (c) Half the velocity of sound towards the source  
 (d) Double the velocity of sound towards the source
25. If the velocity of sound in air is 350 m/s. Then the fundamental frequency of an open pipe of length 50 cm will be:  
 (a) 350 Hz (b) 175 Hz (c) 900 Hz (d) 750 Hz
26. A stretched string of 1m length and mass  $5 \times 10^{-4}$  kg is having tension of 20N. If it is plucked at 25 cm from one end then it will vibrate with frequency:  
 (a) 100 Hz (b) 200 Hz (c) 300 Hz (d) 400 Hz
27. When two sound waves superpose, beats are produced when they have:  
 (a) Different amplitudes and phases (b) Different velocities  
 (c) Different phases (d) Different frequencies
28. The superposition takes place between two waves of frequency ' $f$ ' and amplitude ' $a$ '. The total intensity is directly proportional to:  
 (a)  $a$  (b)  $a^2$  (c)  $\sqrt{a}$  (d)  $1/\sqrt{a}$
29. Which of the following is not the transverse wave?  
 (a) X-rays (b)  $\gamma$ -rays (c) Visible light (d) Sound waves
30. An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency:  
 (a) 5% (b) 20% (c) Zero (d) 0.5%
31. Velocity of sound is maximum in:  
 (a) Air (b) Vacuum (c) Water (d) Steel
32. To make the frequency double of a spring oscillator, we have to:  
 (a) Reduce the mass to one fourth (b) Quadruple the mass  
 (c) Double of mass (d) Half of mass
33. In a second pendulum, mass of bob is 30 gm. If it is replaced by 90 gm mass. Then its time period will:  
 (a) 1 s (b) 2 s (c) 4 s (d) 3 s
34. The time period of simple pendulum is 2s. If its length is increased 4 times, then its period becomes:  
 (a) 16s (b) 2 s (c) 8 s (d) 4 sec
35. The graph between T.E and displacement of a particle executing SHM is:  
 (a) Parabola (b) Hyperbola (c) Straight line (d) Ellipse
36. The K.E and P.E of a particle executing S.H.M will be equal, when displacement is:  
 (a)  $x_0/2$  (b)  $x_0\sqrt{2}$  (c)  $x_0/\sqrt{2}$  (d)  $x_0\sqrt{2}/3$
37. A small body of mass 0.10 kg is executing S.H.M of amplitude 1.0 m and period 0.20 s. The maximum force acting on it is:  
 (a) 98.596 N (b) 100.2 N (c) 76.23 N (d) 985.96 N
38. A particle is executing a motion  $x=A \cos(\omega t-\theta)$ . The maximum velocity of the particle is:  
 (a)  $A \omega \cos \theta$  (b)  $A \omega$  (c)  $A \omega \sin \theta$  (d) None of these

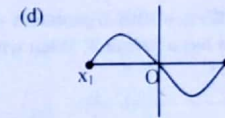
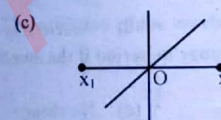
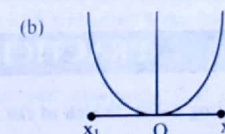
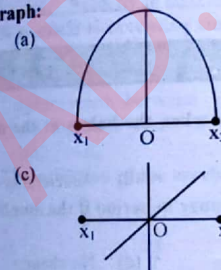
Sr.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.
Ans:	a	a	a	b	d	b	d	b	d	a	b	d	c	c	a	b

39. A particle is moving with constant angular velocity along the circumference of circle. Which of the following statement is true:  
 (a) The particle so moving executes S.H.M  
 (b) The projection of the particle is executing non-periodic motion  
 (c) The projection of the particle on any of the diameter executes S.H.M  
 (d) None of the above

40. A loaded spring vibrates with a period  $T$ . The spring is divided into nine equal parts and the same load is suspended from one of these parts. The new period is:  
 (a)  $T$  (b)  $3T$  (c)  $T/3$  (d)  $T/9$

41. What is the phase difference between velocity and displacement in SHM?  
 (a) 0 (b)  $\frac{\pi}{2}$  (c)  $\frac{\pi}{4}$  (d)  $\pi$

42. A particle of mass  $m$  oscillates with simple harmonic motion between points  $x_1$  and  $x_2$ , the equilibrium position being  $O$ . Its potential energy is plotted. It will be as given below in the graph:



43. A pendulum suspended from the ceiling of a train has a period  $T$  when the train is at rest. When the train is accelerating with a uniform acceleration, the period of oscillation will be:  
 (a) Increases (b) decreases  
 (c) Remain unaffected (d) Become infinite
44. A seconds' pendulum is placed in a space laboratory orbiting around the Earth at a height  $3R$ , where  $R$  is the radius of the Earth. The time period of the pendulum is:  
 (a) Infinite (b) 4 s (c) Zero (d)  $2\sqrt{3}$  s.
45. The equation of SHM of a particle is  $a = 4\pi^2 x$  where  $a$  is instantaneous linear acceleration at displacement  $x$ . The frequency of motion is:  
 (a) 1 Hz (b) 4 Hz (c)  $\frac{1}{4}$  Hz (d) 4 Hz
46. A body of mass  $M$  is suspended from a spring of force constant  $K$  and mass  $m$ . The time period of vertical oscillations is  
 (a)  $2\pi\sqrt{\frac{M}{K}}$  (b)  $2\pi\sqrt{\frac{m}{K}}$  (c)  $2\pi\sqrt{\frac{M+m}{K}}$  (d)  $2\pi\sqrt{\frac{M+m/3}{K}}$

Sr.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	d	c	b	b	b	a	a	a

47. The length of the seconds' pendulum on the surface of Earth is 1 m. Its length on the surface of Moon, where  $g$  is  $\frac{1}{6}$ th the value of  $g$  on the surface of Earth, is

- (a)  $\frac{1}{6}$  m (b) 6m (c)  $\frac{1}{36}$  m (d) 36m

48. The length of simple pendulum is increased by 1%. Its time period will be:

- (a) Increase by 1% (b) Decrease by 0.5% (c) Increase by 0.5% (d) Increase by 2%

49. At what temperature velocity of sound is double then that of at  $0^\circ\text{C}$ :

- (a) 819 K (b)  $819^\circ\text{C}$  (c)  $600^\circ\text{C}$  (d) 600 K

50. Two tuning forks have frequencies 450 Hz and 454 Hz respectively. On sounding these forks together, the time interval between successive maximum intensities will be:

- (a)  $\frac{1}{4}$  sec (b)  $\frac{1}{2}$  sec (c) 4 sec (d) 2 sec

Sr.	47.	48.	49.	50.
Ans:	a	c	b	a

## PRACTICE TEST NO. 5

1. A particle is executing SHM. Which of the following is maximum when the bob is at the mean position?

- (a) Time period (b) Amplitude (c) Velocity (d) Acceleration

2. A simple pendulum has a period  $T$ . What will be the percentage change in period if the amplitude is decreased by 6%?

- (a) 6% (b) 3% (c) 1.5% (d) No change

3. If acceleration due to gravity is halved, then the frequency  $f$  of oscillation of a spring becomes:

- (a)  $2f$  (b)  $4f$  (c)  $\frac{f}{2}$  (d) No effect

4. A uniform spring of force constant  $k$  is cut into two pieces, the lengths of which are in the ratio 1 : 2. The ratio of the force constants of the shorter and the longer pieces is:

- (a) 1 : 2 (b) 2 : 3 (c) 2 : 1 (d) 1 : 3

5. The potential energy of a body executing SHM will be maximum at:

- (a) Equilibrium position (b) Extreme position  
(c) Both at equilibrium and extreme position  
(d) Midway between equilibrium and extreme position

6. The length of a simple pendulum executing simple harmonic motion is increased by 21%. The percentage increase in the time period of the pendulum of increased length is:

- (a) 10% (b) 15% (c) 21% (d) 42%

7. The time period of a simple pendulum measured inside a stationary lift is  $T$ . If the lift starts moving upward with an acceleration of  $g/3$ , what will be its time period?

- (a)  $T/3$  (b)  $3T$  (c)  $\frac{\sqrt{3}}{2}T$  (d)  $\sqrt{\frac{3}{2}}T$

Sr.	1	2	3	4	5	6	7
Ans:	c	d	d	c	b	a	c

8. A simple harmonic oscillator has a period of 0.02 s and an amplitude of 0.05 m. Its velocity at the mean position is:

- (a)  $2\pi \text{ m s}^{-1}$  (b)  $3\pi \text{ m s}^{-1}$  (c)  $4\pi \text{ m s}^{-1}$  (d)  $5\pi \text{ m s}^{-1}$

9. A S.H.M has amplitude 'a' and time period 'T'. The maximum velocity will be:

- (a)  $4a/T$  (b)  $2a/T$  (c)  $2\pi\sqrt{a/T}$  (d)  $2\pi a/T$

10. For a particle executing simple harmonic motion, Which of the following statement is not correct:

- (a) Total energy of the particle always remains the same  
(b) Restoring force always directed towards the fixed point  
(c) Restoring force is maximum at extreme position  
(d) Acceleration of particle is maximum at equilibrium position

11. The total energy of a particle executing S.H.M is proportional to:

- (a) Displacement from equilibrium position (b) Frequency of oscillation  
(c) Velocity in equilibrium position (d) Square of amplitude of motion

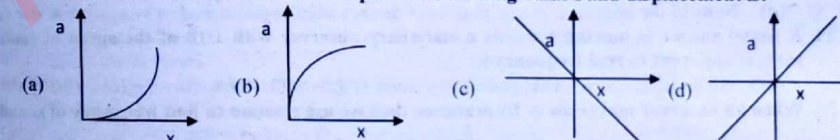
12. A particle is executing simple harmonic motion with frequency  $f$ . the frequency at which its K.E change into P.E is:

- (a)  $f/2$  (b)  $F$  (c)  $2f$  (d)  $4f$

13. Displacement between maximum P.E position and maximum K.E position for a particle executing S.H.M is:

- (a)  $-x_0$  (b)  $+x_0$  (c)  $\pm x_0$  (d)  $\pm x_0/4$

14. The variation of the acceleration  $a$  of the particle executing S.H.M and displacement is:



15. The vertical extension in a light spring by a weight of 1 kg suspended from the wire is 9.8 cm. The period oscillation:

- (a)  $20\pi$  sec (b)  $2\pi$  sec (c)  $2\pi/10$  sec (d)  $200\pi$  sec

16. The relation between phase difference  $\Delta\phi$  and path difference  $\Delta x$  is given as:

- (a)  $\Delta\phi = 2\pi(\Delta x)/\lambda$  (b)  $\Delta\phi = 2\pi\lambda\Delta x$  (c)  $\Delta\phi = 2\pi\lambda/\Delta x$  (d)  $\Delta\phi = 2\Delta x/\lambda$

17. If sound wave of frequency  $f$  is travelling in air with speed  $v$  then sound wave of frequency  $4f$  will travel with speed.

- (a)  $v$  (b)  $4v$  (c)  $2v$  (d)  $v/4$

18. The waves in which the particles of the medium vibrate in a direction perpendicular to the direction of wave motion of waves is known as:

- (a) Transverse wave (b) Longitudinal wave  
(c) Propagated wave (d) None of these

19. If the phase difference between the two waves is  $2\pi$  during superposition, then the resultant amplitude is:

- (a) Maximum (b) Minimum  
(c) Maximum or minimum (d) Neither maximum nor minimum

20. An observer is moving away from source of sound of frequency 100 Hz. His speed is 33 m/s. If speed of sound is 330 m/s, then the observed frequency is:

- (a) 90 Hz (b) 100 Hz (c) 91 Hz (d) 110 Hz

Sr.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans:	d	d	d	d	c	c	c	c		a	a	a	a

21. To increase the frequency from 100 Hz to 400 Hz the tension in the string has to be changed by:  
(a) 4 times (b) 16 times (c) 20 times (d) None of these
22. A source of sound of frequency 450 cycle/sec is moving towards a stationary observer with 34 m/sec speed. If the speed of sound is 340 m/s, then the apparent frequency will be:  
(a) 410 cycles/sec (b) 500 cycles/sec (c) 550 cycles/sec (d) 450 cycles/sec
23. Dimensions of Doppler shift are:  
(a)  $MLT^0$  (b)  $M^0L^{-1}T^0$  (c)  $M^0LT^0$  (d)  $M^0L^{-1}T$
24. Correct value of speed of sound in air was calculated by:  
(a) Newton (b) Laplace (c) Michelson (d) Huygen
25. If pressure of air is doubled the speed of sound in air will become:  
(a) Double (b)  $\sqrt{2}$  times (c)  $1/\sqrt{2}$  times (d) Remains same
26. Superposition of two waves results an interference pattern when they have:  
(a) Same frequency and opposite direction  
(b) Same frequency and same direction  
(c) Slightly different frequencies and same direction  
(d) Different frequencies and different directions
27. Speed of transverse wave in a stretched string are independent of:  
(a) Tension in the string (b) Mass per unit length of string  
(c) Length of string (d) None of these
28. The first overtone in a closed pipe has a frequency:  
(a) Same as the fundamental frequency of an open tube of same length  
(b) Twice the fundamental frequency of an open tube of same length  
(c) Same as that of the first overtone of an open tube of same length  
(d) None of the above
29. A sound source is moving towards a stationary observer with  $1/10$  of the speed of sound. The ratio of apparent to real frequency is:  
(a)  $10/9$  (b)  $11/10$  (c)  $(11/10)^2$  (d)  $(9/10)^2$
30. When an observer moves away from source then we use relation to find frequency of sound as:  
(a)  $f' = \left(\frac{v+u_o}{v}\right)f$  (b)  $f' = \left(\frac{v}{v+u_o}\right)f$  (c)  $f' = \left(\frac{v-u_o}{v}\right)f$  (d)  $f' = \left(\frac{v}{v-u_o}\right)f$
31. In a stationary wave, the distance between a node and consecutive antinode is:  
(a) A quarter of wavelength (b)  $3/4$  of wavelength  
(c) One wavelength (d) Half of wavelength
32. The frequency of applied A.C is 2 K Hz. Its time period will be  
(a)  $0.5 \times 10^{-3}$  sec (b) 0.5 sec (c) 5 sec (d) 2 sec
33. A pendulum undergoes simple harmonic motion. The phase difference between the displacement and the acceleration of the particle is  
(a) 0 (b)  $\frac{\pi}{2}$  (c)  $\pi$  (d)  $\frac{3\pi}{2}$
34. Under the action of the restoring force:  
(a) The speed of the body always increases  
(b) The body moves at constant speed  
(c) The body always slow down  
(d) The body accelerates
35. Superposition of two waves having same frequency, same amplitude and travelling in the opposite direction, is called  
(a) Interference (b) Diffraction  
(c) Beats (d) Stationary waves


Sr.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
Ans:	b	b	c	b	d	b	c	d	a	c	a	a	b	d	d

36. What is the wavelength of the wave if the phase angle between two points of the medium is  $3\pi/4$  and they are separated through a distance of 3 cm?  
(a) 8 cm (b) 1 cm (c) 9 cm (d) 12 cm
37. In a periodic wave, the distance between two consecutive crests is known as  
(a) Wave length (b) Amplitude (c) Displacement (d) None of these
38. The object oscillates due to  
(a) A restoring force (b) Its weight  
(c) Centripetal force (d) Force of friction
39. A longitudinal standing wave, in second harmonic mode, is established in a tube that is open at both ends. The length of the tube is 0.80 m. What is the wavelength of the waves that make up the standing wave?  
(a) 0.20 m (b) 0.40 m (c) 0.80 m (d) 1.60 m
40. Whenever a transverse wave travelling in a denser medium, is reflected from the boundary of the rarer medium:  
(a) The direction of its displacement remains same  
(b) The direction of its displacement is reversed  
(c) The displacement disappears  
(d) The displacement becomes double
41. The speed of sound in water is approximately:  
(a) 1500 m/s (b) 5000 m/s (c) 330 m/s (d) 50 m/s
42. A stationary wave is formed in a pipe which is open at one end. If length of pipe is L, then what is the maximum possible wavelength of the wave?  
(a) L (b) 2L (c) 3L (d) 4L
43. The phenomenon of polarization of light reveals that light waves are: .....  
(a) Transverse waves (b) Longitudinal waves  
(c) Mechanical waves (d) None of these
44. What is true about acceleration of an object undergoing simple harmonic motion?  
(a) Acceleration is minimum when velocity is maximum  
(b) Acceleration is proportional to the frequency of oscillation  
(c) Acceleration is in opposite direction to its velocity  
(d) Acceleration is minimum when potential energy is maximum
45. In simple harmonic motion, which two quantities are always in opposite direction?  
(a) Kinetic energy and potential energy (b) Kinetic energy and velocity  
(c) Velocity and acceleration (d) Acceleration and displacement
46. A longitudinal standing wave, in second harmonic mode, is established in a tube open at both ends. The frequency of the standing wave is 660 Hz, and the speed of sound in air is 330 m/s. What is the length of the tube?  
(a) 0.5 m (b) 1 m (c) 1.5 m (d) 2 m
47. The period of a spring oscillating in SHM is:  
(a)  $T = 2\pi\sqrt{\frac{m}{k}}$  (b)  $T = 2\pi\sqrt{\frac{k}{m}}$  (c)  $T = 2\pi\sqrt{\frac{m}{2k}}$  (d)  $T = 2\pi\sqrt{\frac{2m}{k}}$
48. In Boyle's law, which quantity is constant  
(a) P (b) T (c) V (d) R
49. A stationary wave is set up in a pipe of length L, which is open from both ends. There are three nodes. How many antinodes are there in the stationary wave?  
(a) 2 (b) 3 (c) 4 (d) 6
50. A transverse wave is reflected from a rigid support. The change in phase on reflection will be:  
(a) Zero (b)  $\pi/2$  (c)  $\pi$  (d)  $2\pi$

Sr.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	a	a	c	a	a	b	a	a	d	a	a	b	c	c

51. The distance moved by a particle in simple harmonic motion in one time period is:  
(a) A (b) 2A (c) 4A (d) Zero
52. A pendulum clock keeping correct time is taken to high altitudes.  
(a) It will keep correct time.  
(b) Its length should be increased to keep correct time.  
(c) Its length should be decreased to keep correct time.  
(d) It cannot keep correct time even if the length is changed.
53. The bob of a simple pendulum is kept oscillating by the  
(a) Gravitational force (b) Electrical force (c) Magnetic force (d) Viscous force
54. The time period of a mass suspended from a spring is T. If the spring is cut into four equal parts and the same mass is suspended from one of the parts, then the new time period will be:  
(a)  $\frac{T}{4}$  (b) T (c)  $\frac{T}{2}$  (d) 2T
55. What fraction of the total energy is kinetic when the displacement is one-half of the amplitude?  
(a)  $\frac{1}{4}$  (b)  $\frac{2}{4}$  (c)  $\frac{3}{4}$  (d)  $\frac{3.5}{4}$
56. The length of a seconds' pendulum is approximately:  
(a) 994 mm (b) 99.3 mm (c) 993 cm (d) 9.93 m
57. A simple harmonic oscillator has an amplitude 'a' and time period 'T'. The time required by it to travel from  $x=0$  to  $x=a/2$  is:  
(a) T/6 (b) T/3 (c) T/4 (d) T/12
58. A particle is performing simple harmonic motion with amplitude A and angular velocity  $\omega$ . The ratio of maximum velocity to maximum acceleration is:  
(a)  $\omega$  (b)  $1/\omega$  (c)  $2\omega$  (d)  $A\omega$
59. The amplitude of a particle executing S.H.M with frequency of 60 Hz is 0.01 m. The maximum value of acceleration of the particle is:  
(a)  $144\pi^2 \text{ m/s}^2$  (b)  $144\pi \text{ m/s}^2$  (c)  $144/\pi^2 \text{ m/s}^2$  (d)  $288\pi^2 \text{ m/s}^2$
60. A particle executes S.H.M along a straight line with an amplitude A. The P.E is maximum when the displacement is:  
(a)  $\pm A$  (b)  $\pm A/2$  (c) Zero (d)  $\pm A/\sqrt{2}$

Sr.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.
Ans:		c	a	c	c	a	d	b	a	a

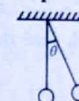
1. The time period of simple pendulum when it is made to oscillate on the surface of moon:  
(a) Increases (b) Decreases (c) Remains unchanged (d) Becomes infinite
2. A uniform spring of force constant k is cut into two pieces, the lengths of which are in the ratio 1:2. The ratio of the force constants of the shorter and the longer pieces is:  
(a) 1:3 (b) 1:2 (c) 2:3 (d) 2:1
3. Figure shows transverse wave of frequency 100 Hz travelling in stretched string then speed of the wave will be:  
  
(a) 5 m/s (b) 10 m/s (c) 15 m/s (d) 20 m/s
4. If the temperature of the atmosphere is increased then which of the following character of the sound wave is affected:  
(a) Amplitude (b) Frequency (c) Velocity (d) Pitch
5. The beats are produced by two sound sources of same amplitude and for nearly equal frequencies. The maximum intensity of beats will be ..... that of one source;  
(a) Same (b) Double (c) Four times (d) Eight times
6. A string of length  $\ell$  is fixed at both ends is vibrating in two segments. The wave length of the corresponding wave is:  
(a)  $\frac{\ell}{4}$  (b)  $\frac{2\ell}{2}$  (c)  $\ell$  (d)  $2\ell$
7. A closed pipe and an open pipe have their first overtones identical in frequency. Their length are in the ratio:  
(a) 1:2 (b) 2:3 (c) 3:4 (d) 4:5
8. An observer is moving towards the stationary source of sound, then:  
(a) Apparent frequency will be less than the real frequency  
(b) Apparent frequency will be greater than the real frequency  
(c) Apparent frequency will be equal to real frequency  
(d) The quality of sound will change
9. A string is attached with a vibrator having frequency 100 Hz. If the distance between two consecutive crest is 2 cm then speed of the wave is:  
(a) 1 m/s (b) 2 m/s (c) 10 m/s (d) 20 m/s
10. According to Newton, Modulus of elasticity of air is:  
(a)  $1 \times 10^2 \text{ Pa}$  (b)  $1.4 \times 10^5 \text{ Pa}$  (c)  $1 \times 10^5 \text{ Pa}$  (d) zero
11. With two degree rise in temperature the speed of sound in air increases by:  
(a) 0.61 m/s (b) 1.2 m/s (c) 61 cm (d) Both a and c
12. When two tuning forks are sounded together the beat frequency is 3 Hz. If one tuning fork has frequency 480 Hz the frequency of other tuning fork may be:  
(a) 477 Hz (b) 483 Hz (c) 486 Hz (d) Both a and b
13. A 16cm string is vibrating in four segments with frequency 100 Hz then the frequency of third harmonic will be:  
(a) 25 Hz (b) 75 Hz (c) 125 Hz (d) 500 Hz
14. The fundamental note produced by a closed organ pipe is of frequency 'f'. The fundamental note produced by an open organ pipe of same length will be of frequency:  
(a)  $f/2$  (b) f (c) 2f (d) 4f

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	a	d	d	c	c	c	c	b	b	c	b	d	b	c

15. A source emits a sound of wavelength 30 cm, but the listener observes wavelength 32 cm. Then,  
 (a) Listener is moving towards the source  
 (b) Listener is moving away from source  
 (c) Source is moving towards the listener  
 (d) Source is moving away from listener
16. When a source moves towards a stationary observer then we use relation to find frequency of sound as?  
 (a)  $f' = \left(\frac{v}{v+u_s}\right)f$  (b)  $f' = \left(\frac{v}{v-u_s}\right)f$  (c)  $f' = \left(\frac{v+u_s}{v}\right)f$  (d)  $f' = \left(\frac{v-u_s}{v}\right)f$
17. Ten complete waves pass through a point in 2 seconds. If the wavelength is 20 cm, what is the speed of the wave?  
 (a) 1 m/s (b) 10 cm/s (c) 2 m/s (d) 40 cm/s
18. Which of the following frequency of sound wave is not audible?  
 (a) 5 Hz (b) 5000 Hz (c) 2500 Hz (d) 50 kHz
19. Acceleration in the simple pendulum is always \_\_\_\_\_ to displacement.  
 (a) Inversely proportional (b) Directly proportional (c) Acting negative (d) Independent
20. An object undergoes simple harmonic motion, its amplitude is  $x_0$ . The speed of the object is  $v$  when its displacement is  $x_0/3$ . What is the speed when its displacement is  $x_0$ ?  
 (a)  $v/3$  (b)  $3/2v$  (c)  $2v$  (d) 0
21. Two travelling waves of the same frequency, same amplitude and travelling in same direction result in:  
 (a) Beats (b) Standing waves (c) Diffraction (d) Interference
22. Two waves interfere constructively, if the path difference between them must be:  
 (a)  $(2n+1)\lambda$  (b)  $(2n+1)\lambda/2$  (c)  $(2n+1)\lambda/3$  (d)  $n\lambda$
23. Which of the following statements about wave motion is true:  
 (a) Waves transport energy and matter  
 (b) Waves transport energy without transporting matter  
 (c) Waves transport matter but not energy  
 (d) None of these
24. A pipe is open at both ends. A stationary wave is formed in the air of the pipe. Which statement is true:  
 (a) There is always a central anti node  
 (b) There is always a central node  
 (c) The sum of number of nodes and the number of antinodes is always an even number  
 (d) The sum of number of nodes and the number of antinodes is always an odd number
25. When path difference between two waves are odd integral multiple of half the wavelength, the resultant effect is called:  
 (a) Destructive interference (b) Constructive interference  
 (c) Beats (d) Diffraction
26. A wave have the speed of 0.50 m/s. If its wavelength is 1.5 m. What is the period of the wave?  
 (a) 0.33s (b) 3s (c) 1.5s (d) 6s
27. In stationary waves  
 (a) Strain is maximum at antinodes  
 (b) Strain is minimum at nodes  
 (c) Strain is maximum at node  
 (d) Amplitude is same at all points

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	c	b	a	a	b	d	d	d	b	d	a	b	b

28. In a travelling wave, five complete waves passes through a points in 10 seconds. Frequency of the wave is:  
 (a) 0.5 Hz (b) 5 Hz (c) 50 Hz (d) 15 Hz
29. The distance between the consecutive wave fronts is equal to:  
 (a) One wavelength (b) Two wavelengths  
 (c) Radius (d) Diameter
30. A stationary wave is set up in a pipe of length L, which is open from one end. There are three nodes. How many antinodes are there in the stationary wave?  
 (a) 2 (b) 3 (c) 4 (d) 6
31. A simple pendulum has mass M, length L and time period T. What is the period of oscillation of the pendulum with mass 4M and length 36L?  
 (a) 6T (b) T (c) 2T (d) 3T
32. A simple pendulum length 'L' with bob of mass 'm' is slightly displaced from its mean position so that it string makes an angle ' $\theta$ ' with vertical line as shown in the figure. Then bob of pendulum released. What will be the expression of torque with which the bob starts to move towards the mean position?

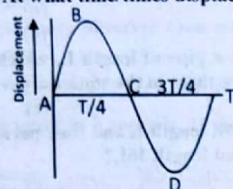


- (a)  $mgL$  (b)  $mgL \sin \theta$  (c) 0 (d)  $mgL \cos \theta$
33. Ratio of moment of inertia of two objects 'A' and 'B' is 2:3. Which one of the following is the ratio of torques of 'A' And 'B' respectively, if both are being rotated with constant angular acceleration?  
 (a) 3:4 (b) 3:2 (c) 2:3 (d) 4:3
34. For interference of light waves to take place, the required condition is  
 (a) The path difference of the light waves from the two source must be large  
 (b) The interfering waves must be non-coherent  
 (c) The light waves may come from different sources  
 (d) The light waves may come from two coherent sources
35. The property of bending of light around an obstacle and spreading of light waves into geometric shadow of an obstacle is called:  
 (a) Diffraction (b) Polarization  
 (c) Quantization of Light (d) Interference of light
36. For constructive interference the path difference is:  
 (a)  $\left(n + \frac{1}{2}\right)\lambda$  where  $n = 0, 1, 2, \dots$  (b)  $n\lambda$  where  $n = 0, 1, 2, \dots$   
 (c)  $(2n+1)\lambda$  where  $n = 0, 1, 2, \dots$  (d)  $\left(\frac{n+1}{2}\right)\lambda$  where  $n = 0, 1, 2, \dots$
37. A source of sound wave emits waves of frequency 'f'. If 'v' is speed of sound waves, then what will be the wavelength of the waves:  
 (a)  $\frac{v}{f}$  (b)  $\frac{v-u_o}{f}$  (c)  $vf$  (d)  $(v-u_o)f$
38. The spectrum of a star's light is measured and the wavelength of one of the lines as the sodium's line is found to be 589 nm. The same line has the wavelength of 497 nm when observed in the laboratory. This means the star is:  
 (a) Moving away from the earth (b) Moving towards the north  
 (c) Stationary (d) Revolving around the planet

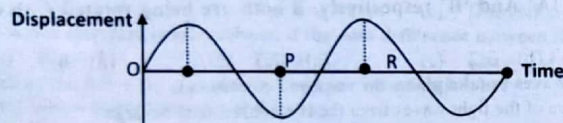
Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.
Ans:	a	a	b	a	b	c	d	a	b	a	a

39. What is the period of mass spring system during SHM if the ratio of mass to spring constant is  $\frac{1}{4}$ ?
- (a)  $\pi$  (b)  $1/\pi$  (c)  $2\pi$  (d)  $\frac{1}{2}\pi$

40. Waveform of SHM is given in figure. At what time/times displacement is equal to zero?



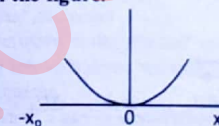
- (a)  $T/4$  only (b)  $3T/4$  only (c)  $0, T/4, 3T/4$  and  $T$  (d)  $0, T/2$  and  $T$
41. A simple harmonic oscillator has a time period of 1 seconds. Which equation relates its acceleration 'a' and displacement 'x'?
- (a)  $a = -2x$  (b)  $a = -(2\pi)x$  (c)  $a = -\left(\frac{2\pi}{10}\right)^2 x$  (d)  $a = -(2\pi)^2 x$
42. When the length of simple pendulum is doubled, find the ratio of the new frequency to the old frequency?
- (a)  $\frac{1}{4}$  (b)  $\sqrt{2}$  (c)  $\frac{1}{2}$  (d)  $1/\sqrt{2}$
43. In the diagram below, the displacement of an oscillating particle is plotted against time. What does the length 'PR' on the time axis represents?



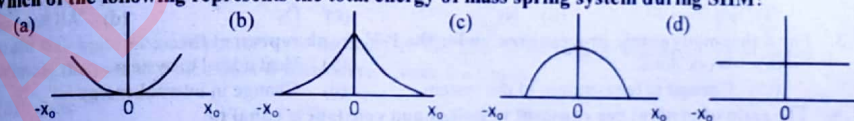
- (a) Twice the frequency (b) Half the period  
(c) Half the frequency (d) Twice the period
44. When the source of sound moves towards the stationary observer, the value of apparent frequency 'f<sub>a</sub>' is:
- (a)  $f_0 = \left(\frac{v+u_o}{v}\right) f$  (b)  $f_0 = \left(\frac{v}{v+u_s}\right) f$  (c)  $f_0 = \left(\frac{v}{v-u_s}\right) f$  (d)  $f_0 = \left(\frac{v-u_o}{v}\right) f$
45. For vibrating mass-spring system, the expression of kinetic energy at any displacement 'x' is given by:
- (a)  $\frac{1}{2} kx_0^2 \left(1 - \frac{x^2}{x_0^2}\right)$  (b)  $\frac{1}{2} kx_0^2$   
(c)  $\frac{1}{2} m\omega^2 \left(1 - \frac{x^2}{x_0^2}\right)$  (d)  $\frac{1}{2} m\omega^2 x_0$
46. Speed of sound through a gas is measured as 340 m/s at pressure  $P_1$  and temperature  $T_1$ . What will be the speed of sound if pressure of gas is doubled but temperature is kept constant?
- (a) 342 m/s (b) 340 m/s (c) 170 m/s (d) 680 m/s
47. What should be the length of simple pendulum whose period is 6.28 second at a place where  $g = 10 \text{ ms}^{-2}$ .
- (a) 0.28 m (b) 6.28 m (c) 10.8 m (d) 10 m
48. What should be the ratio of kinetic energy to total energy for simple harmonic oscillator?
- (a)  $1 - \frac{x^2}{x_0^2}$  (b)  $(x_0^2 - x^2)$  (c) 1 (d)  $\frac{1}{2} \frac{x^2}{x_0^2}$

Sr.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.
Ans:	a	d	d	d	b	c	a	b	d	a

49. In a simple harmonic motion with a radius ' $x_0$ ', the velocity of the particle at any point is:
- (a)  $v = \omega\sqrt{x_0^2 - x^2}$  (b)  $v = \omega(x^2 - x_0^2)$   
(c)  $v = \omega(\sqrt{x_0 - x})$  (d)  $v = \omega\sqrt{(x - x_0)}$
50. Frequency of simple pendulum of length 9.6 m will be:
- (a)  $2\pi$  Hertz (b)  $1/2\pi$  Hertz (c)  $\pi/2$  Hertz (d)  $\pi/4$  Hertz
51. A body performs simple harmonic motion with a period of 0.063 s. The maximum speed of  $3.0 \text{ ms}^{-1}$ . What are the values of the amplitude ' $x_0$ (m)' and angular frequency ' $\omega$  (rads<sup>-1</sup>)'?
- (a)  $x_0 = 0.03, \omega = 100$  (b)  $x_0 = 0.19, \omega = 16$   
(c)  $x_0 = 5.3, \omega = 16$  (d)  $x_0 = 3.3, \omega = 100$
52. Food being cooked in microwave oven is an example of:
- (a) Beats (b) Overtones (c) Resonance (d) Stationary waves
53. Potential energy of a mass spring system with respect to displacement during simple harmonic motion (SHM) is shown in the figure.



Which of the following represents the total energy of mass spring system during SHM?



54. Mathematical formula of maximum velocity ( $v_0$ ) for a body executing simple harmonic motion is:
- (a)  $v_0 = \omega x_0$  (b)  $v_0 = \frac{k}{m} \sqrt{x_0^2 - x^2}$   
(c)  $v_0 = v \sqrt{1 - \frac{x^2}{x_0^2}}$  (d)  $v_0 = m \sqrt{x_0^2 - x^2}$
55. An observer moves with velocity ' $v_0$ ' towards a stationary source, then the number of waves received in one second is:
- (a)  $f = f \left( \frac{v}{v+v_0} \right)$  (b)  $f = f \left( \frac{v}{v-v_0} \right)$  (c)  $f = f \left( \frac{v+v_0}{v} \right)$  (d)  $f = f \left( \frac{v-v_0}{v} \right)$
56. Resonance occurs when the driving frequency is:
- (a) Greater than natural frequency (b) Unequal the natural frequency  
(c) Less than natural frequency (d) Equal to the natural frequency
57. The red shift measurement of Doppler effect of galaxies indicate that the universe is:
- (a) Expanding (b) Contracting (c) Stationary (d) Oscillating
58. Frequency audible range to human hearing lies in the range:
- (a) 2-2000 kHz (b) 15-50000 kHz (c) 20-20000 kHz (d) 20-20000 kHz

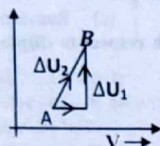
Sr.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.
Ans:	a	b	a	c	d	a	c	d	a	c

## UNIT 05 &gt;&gt;

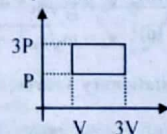
HEAT AND  
THERMODYNAMICS

## PRACTICE TEST NO. 1

1. A gas changes its state from A to B along different path then which of the following relation is true about change in internal energies:



- (a)  $\Delta U_1 = \Delta U_2$  (b)  $\Delta U_1 > \Delta U_2$  (c)  $\Delta U_1 < \Delta U_2$  (d)  $\Delta U_1 = \Delta U_2 = 0$
2. At room temperature which of the following gas molecules have greater average K.E.  
(a)  $H_2$  (b)  $N_2$  (c)  $O_2$  (d) All have same
3. For a thermodynamic process area under the P-V graph represent the:  
(a) Work done (b) Heat added to system  
(c) Change in temperature of the system (d) Change in internal energy
4. The ratio of general gas constant to Boltzmann constant is equal to:  
(a)  $8.314 \text{ J mol}^{-1} \text{ K}^{-1}$  (b)  $6.02 \times 10^{23} \text{ mol}^{-1}$  (c)  $1.38 \times 10^{-23} \text{ JK}^{-1}$  (d) One
5. P-V diagram for a cyclic process is shown in the figure below, then work done will be:



- (a) PV (b) 4PV (c) 9PV (d) Zero
6.  $2PV = RT$  is ideal equation for:  
(a) 1 mole (b) 2 moles (c) 0.5 moles (d) 0.25 moles
7. 1<sup>st</sup> law of thermodynamics is modified form of law of conservation of:  
(a) Mass (b) Energy (c) Momentum (d) All of these
8. According to 1<sup>st</sup> law of thermodynamics change in internal energy of the system is given as:  
(a)  $Q + W$  (b)  $Q - W$  (c)  $W - Q$  (d)  $Q$
9. If a gas undergoes a cyclic process the its change in internal energy will be zero:  
(a) Positive (b) Negative (c) Zero (d) Area of the cycle
10. For which of the following process heat energy is entirely converted into mechanical energy:  
(a) Isothermal expansion (b) Adiabatic expansion  
(c) Isothermal compression (d) Adiabatic compression
11. In which of the following process mechanical energy is entirely converted into internal energy?  
(a) Isothermal expansion (b) Adiabatic expansion  
(c) Isothermal compression (d) Adiabatic compression

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Ans:	a	d	a	c	b	c	b	b	c	a	d

12. If 5 kg and 10 kg water are heated then the ratio between their heat capacity will be:  
(a) 1:2 (b) 2:1 (c) 1:1 (d) 1:4

13. The ratio of unit of specific heat to unit of heat capacity is:  
(a)  $\text{Kg}^{-1}$  (b)  $\text{Kg}$  (c)  $\text{K}$  (d)  $\text{K}^{-1}$
14. Specific heat of an idea gas for an adiabatic process is:  
(a) Zero (b) One (c) Infinity (d) Negative
15. For an ideal gas if  $C_v = \frac{3}{2} R$  then  $C_p = ?$   
(a)  $R/2$  (b)  $3R/2$  (c)  $5R/2$  (d)  $7R/2$
16. For an ideal gas the ratio  $C_v/C_p$  is always:  
(a) Equal to one (b) Less than one (c) Equal or less than one (d) Equal or greater than 1

17. A fixed mass of an ideal gas is contained in a cylinder at constant temperature. Now the pressure of the gas is decreased. What happened to the molecules of gas?  
(a) Their mean square speed decreases  
(b) Number of collision between molecules and walls of container decreased  
(c) The force of attraction between them increase  
(d) Its internal energy decreases

18. If  $N$  is the number of molecules of a gas in a container. Then number of moles can be calculated as:

- (a)  $N + N_A$  (b)  $N_A \times N$  (c)  $\frac{N}{N_A}$  (d)  $N - N_A$

19. A liquid has mass  $m$  and specific heat capacity  $c$ . The rate of change in temperature of liquid is  $R$ . What is the rate at which heat is transferred from the liquid.

- (a)  $Rmc$  (b)  $R + mc$  (c)  $mc - R$  (d)  $\frac{Rm}{c}$

20. Which statement is incorrect?

- (a) In a isobaric process  $\Delta P = 0$  (b) In a isochoric process  $\Delta W = 0$   
(c) In a isothermal process  $\Delta T = 0$  (d) In a isothermal process  $\Delta Q = 0$

21. In adiabatic expansion

- (a)  $\Delta U = 0$  (b)  $\Delta U = \text{negative}$  (c)  $\Delta U = \text{positive}$  (d)  $\Delta W = 0$

22. An ideal reversible heat engine is 100% efficient only if:

- (a) Hot reservoir is at  $0\text{K}$  (b) Hot reservoir is at  $0\text{C}$   
(c) Cold reservoir is at  $0\text{C}$  (d) Cold reservoir is at  $0\text{K}$

23. An adiabatic change is the one in which:

- (a) No heat is added to or taken out of a system  
(b) No change of temperature takes place  
(c) Boyle's law is applicable  
(d) Pressure and volume remains constant

24. A thermodynamic system undergoes a process in which its internal energy decreases by 300 J. If at the same time 120 J of work is done on the system, find the heat lost by the system.

- (a) -420J (b) 80J (c) 420J (d) -80J

25. The efficiency of Carnot engine can never be 1, because:

- (a) We cannot achieve the higher temperature  
(b) We do not have an ideal working substance  
(c) There is always energy losses  
(d) We need cold reservoir at absolute zero temperature, which is not available

Sr.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	a	a	c	b	a	d	b	d	a	a	d

26. During an isothermal process which of the following is true?  
 (a) Temperature always increases (b) Temperature always decreases  
 (c)  $\Delta W = \Delta Q$  (d) None of them
27. Which of the following is an example of isothermal process?  
 (a) The rapid escape of air from a burst tyre  
 (b) The rapid expansion and compression of air through which a sound wave is passing  
 (c) Cloud formation in the atmosphere  
 (d) Slow compression or expansion of gas
28. Under what conditions of density and pressure does a real gas approximate to an ideal gas?  
 (a) High density and high pressure (b) Low density and low pressure  
 (c) High density and low pressure (d) Low density and high pressure
29. Which of the following is a thermodynamic coordinate:  
 (a) P (b) T (c) V (d) R
30. Acceleration of earth around sun in its orbit is always:  
 (a) Tangential (b) Radial (c) Zero (d) None of these
31. Specific latent heat of fusion of ice is 334 J/g. How much energy is needed to melt 100 g of ice at 0°C.  
 (a) 33.4 J (b) 33.4 kJ (c) 3.34 J (d) 3.34 kJ
32. 300 W heater is used to boil 500g of water at 100°C. How long should the heater be switched on?  
 Specific latent of vaporization of water is 2230 J/g.  
 (a) 62 min (b) 62 sec (c) 1.5 hour (d) 0.5 hour
33. A 1.0 kW heater supplies energy to a liquid of mass 1 kg. The temperature of the liquid changes by 80 K in a time of 400 s. The specific heat capacity of the liquid is 4.0 kJ / kg.K. What is the average power lost by the liquid?  
 (a) 100 (b) 200 (c) 400 (d) 800
34. 100 W heater is switched on for 5 minutes to melt ice. What is the mass of ice that melts at 0°C.  
 Specific latent heat of fusion of ice is 334 J/g:  
 (a) 90 g (b) 90 kg (c) 1.5 g (d) 1.5 kg
35. Work done in an adiabatic process in a gas depends on  
 (a) Change in pressure (b) Change in temperature  
 (c) Change in volume (d) All of these
36. Adiabatic process can be defined as:  
 (a)  $PV^\gamma = \text{constant}$  (b)  $PV^\gamma = RT$   
 (c)  $P/V^\gamma = \text{constant}$  (d)  $P/V^\gamma = nRT$
37. Internal energy remains same throughout the process is  
 (a) Adiabatic process (b) Isothermal process  
 (c) Cyclic process (d) Both (a) and (b)
38. Initial pressure and volume are P and V respectively. First it expanded isothermally to 4V then compressed isobarically to volume V, the final pressure is  
 (a) 2P (b) 1P (c) 3P (d) 4P
39. Two containers X and Y are filled with an ideal gas. X has 1 mol of gas and Y has 2 mol of gas. Volume of Y is four times that of X. Pressure in Y is half that in X. What is temperature of gas in Y \_\_\_\_\_ temperature of gas in X:  
 (a) is equal to (b) is double of (c) is half of (d) is one fourth of
40. During adiabatic expansion internal energy decreases by 2J, then work done in this process is:  
 (a) 2J (b) 1J (c) -1J (d) -2J
41. The engine is supposed to work between 727 degree C and 227 degree C, then maximum possible efficiency is  
 (a)  $\frac{1}{2}$  (b)  $\frac{1}{4}$  (c)  $\frac{3}{4}$  (d) 1

Sr.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.
Ans:	c	d	a	d	b	a	b	b	a	c	a	b	d	a	a	a

When heat is given to isobaric process then:

- (a) Work is done by the gas (b) Internal energy of gas decrease  
 (c) Work is done on the gas (d) Both a and b
43. The efficiency of diesel engine is:  
 (a) 10% to 20% (b) 20% to 35% (c) 35% to 40% (d) 40% to 50%

44. According to 1<sup>st</sup> law of thermodynamics, when heat is added to a system it appears as:

- (a) Increase in internal energy  
 (b) Work done by the system  
 (c) Either increase in internal energy or work done by the system  
 (d) Increase in internal energy plus work done by the system

45. For mono atomic ideal gas  $C_v = ?$

- (a)  $3R/2$  (b)  $5R/2$  (c)  $7R/2$  (d)  $9R/2$

46. What does the constant N represent in the equation of state for an ideal gas  $PV = NkT$ ?

- (a) Number of molecules of gas (b) Number of moles of the gas  
 (c) Number of nucleons (d) Measuring a voltage

47. An ideal reversible heat engine has:

- (a) 1 efficiency  
 (b) Highest efficiency  
 (c) An efficiency which depends on the nature substance  
 (d) None of these

48. 100 W heater is used for 5 minutes to heat 500 g of water. What is the change in temperature of water? Specific heat capacity of water is 4.2 J/g°C.

- (a) 140C (b) 40C (c) 0.2C (d) 14C

49. Work done in a isobaric process is given by:

- (a)  $PdT$  (b)  $VdP$  (c)  $PdV$  (d)  $P^2dV$

50. A gas is compressed to half of its initial volume at constant pressure  $10^5$  Pa. If its initial volume is 1000 cm<sup>3</sup> then work done is:

- (a) 50J (b) 100 J (c) 200J (d) -50 J

Sr.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	c	d	a	a	b	d	c	a

## PRACTICE TEST NO. 2

1. Work done by gas, pressure and change in volume are related as:

- (a)  $W = \frac{\Delta V}{P}$  (b)  $W = P\Delta V$  (c)  $W = P + \Delta V$  (d)  $W = P - \Delta V$

2. The work done can also be calculated by:

- (a) Gradient of tangent of the, curve of P-V graph  
 (b) Area of the curve under P-V graph  
 (c) Area of the, curve under P-T graph  
 (d) Gradient of tangent of the, curve of P-T graph

3. Which of the following cannot determine the state of thermodynamic system?

- (a) P and V (b) P and T (c) T and V (d) P and R

4. Which of this is constant in isothermal process?

- (a) Total heat (b) Work done (c) Entropy (d) Internal energy

5. Specific heat of water is

- (a) 1J/K.g (b) 4.18 J/Kg.K (c) 4180 J/kgK (d) 2090 J/kgK

Sr.	1	2	3	4	5
Ans:	b	b	d	d	c

6. A monatomic gas is heated from temperature  $T_1$  and  $T_2$  under two different conditions at (i) constant volume and (ii) constant pressure. So change in  $U$  (internal energy) is  
 (a) More for (i) (b) More for (ii)  
 (c) Same for both (d) Independent of number of moles
7. If 1 mole of an ideal gas is heated at constant volume so that its temperature rises by  $\Delta T$ , then first law of thermodynamics can be written as:  
 (a)  $\Delta U + C_v = \Delta T$  (b)  $\Delta U = C_v - \Delta T$   
 (c)  $\Delta U = C_v \Delta T$  (d)  $\Delta U = C_v + \Delta T$
8. The waves which propagate by the oscillation of material particles are called:  
 (a) Matter waves (b) Mechanical waves  
 (c) Ultrasound waves (d) Microwaves
9. An ideal gas of  $n$  moles is enclosed in a container at a constant pressure  $p$ . The graph between volume of gas and its absolute temperature is a straight line. What is the gradient of the graph?  
 (a)  $\frac{nR}{p}$  (b)  $nRp$  (c)  $\frac{n}{Rp}$  (d)  $\frac{nP}{R}$
10. Which of the following about  $C_p$  and  $C_v$  is correct?  
 (a)  $C_p + C_v = R$  (b)  $C_p = R - C_v$  (c)  $C_p + R = C_v$  (d)  $C_p = R + C_v$
11. When an ideal gas of constant mass is heated in a container of fixed volume. What is the reason for the increase in pressure of the gas?  
 (a) Number of molecules per unit volume increase  
 (b) Molecules occupy greater volume of the container  
 (c) Average force per impact at the container wall increase  
 (d) Molecules collide with each other with greater force
12. The molar specific heat of a diatomic gas is measured at constant volume and found to be  $29.1 \text{ J/mol.K}$ . What are the types of energy that are contributing to the molar specific heat?  
 (a) Translation only (b) Translation and rotation only  
 (c) Translation and vibration only (d) Translation, rotation and vibration
13. The sum of all forms of molecular energies (kinetic and potential) of a substance is termed as its:  
 (a) Absolute temperature (b) Internal energy  
 (c) Potential energy (d) Kinetic energy
14. The internal energy change in system that has absorbed  $2 \text{ kcal}$  of heat and done  $500 \text{ J}$  of work is  
 (a)  $8900 \text{ J}$  (b)  $8800 \text{ J}$  (c)  $7900 \text{ J}$  (d)  $7500 \text{ J}$
15. Under a cyclic path, internal energy after complete cycle is same as  
 (a)  $2(\text{initial})$  (b) Initial heat  
 (c) Initial internal energy (d) Initial work
16. An ideal gas is compressed to half of its initial volume. Which of these processes would result in maximum work done?  
 (a) Adiabatic (b) Isobaric (c) Isochoric (d) Isothermal
17. Two containers hold an ideal gas at the same temperature and pressure. Both containers hold the same type of gas, but container B has twice the volume of container A. What is the average translational kinetic energy per molecule in container B?  
 (a) Twice that of container A (b) The same as that of container A  
 (c) Half that of container A (d) Impossible to determine
18. In thermodynamics zeroth law is related with  
 (a) Work (b) Energy (c) Thermal equilibrium (d) Entropy
19. Which of the following is the adiabatic process:  
 (a) Conduction (b) Convection  
 (c) Radiation (d) None of these

Sr.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
Ans:	a	c	c	a	d	c	d	b	c	c	b	b	c	d

20. Under what conditions of temperature and pressure does a real gas approximate to an ideal gas?  
 (a) Low temperature and low pressure  
 (b) Low temperature and high pressure  
 (c) High temperature and low pressure  
 (d) High temperature and high pressure
21. Which of the following is an assumption of the kinetic model of an ideal gas?  
 (a) Gas is at high pressure  
 (b) Collision between particles are elastic  
 (c) There are weak forces of attraction between particles in gas  
 (d) Total energy of particles is proportional to the temperature
22.  $100 \text{ W}$  heater is used for  $5 \text{ minutes}$  to heat some water from  $20^\circ\text{C}$  to  $50^\circ\text{C}$ . What is the mass of water which is heated? Specific heat capacity of water is  $4.2 \text{ J/g}^\circ\text{C}$ .  
 (a)  $4 \text{ g}$  (b)  $40 \text{ g}$  (c)  $240 \text{ g}$  (d)  $24 \text{ g}$
23. The value of universal gas,  $R$ , constant is \_\_\_\_\_  
 (a)  $8.314 \text{ J/mol}^\circ\text{K}$  (b)  $1.38 \times 10^{-23} \text{ J/K}$   
 (c)  $6.63 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$  (d)  $1.6 \times 10^{-19} \text{ C}$
24. A gas expands from  $V_1$  to  $V_2$  at pressure  $P$ . Work done is:  
 (a)  $P/(V_2 - V_1)$  (b)  $(P_2 - P_1) V$  (c)  $P(V_1 V_2 / (V_2 - V_1))$  (d)  $P(V_2 - V_1)$
25. Isothermal process can be defined as:....  
 (a)  $PV = \text{constant}$  (b)  $PV = RT$  (c)  $P/V = \text{constant}$  (d)  $P/V = Nrt$
26. One  $\text{kcal} =$   
 (a)  $4.18 \text{ J}$  (b)  $2.09 \text{ J}$  (c)  $4180 \text{ J}$  (d)  $2090 \text{ J}$
27. First law of thermodynamics state  
 (a) System can do work (b) System has temperature  
 (c) System has pressure (d) Heat is form of energy
28. A monatomic ideal gas is thermally insulated, so no heat can flow between it and its surroundings. Is it possible for the temperature of the gas to rise?  
 (a) Yes, The temperature can rise if work is done by the gas  
 (b) No. The only way that the temperature can rise is if heat is added to the gas  
 (c) Yes. The temperature can rise if work is done on the gas  
 (d) No. The only way that the temperature can rise is by adding more molecules in container
29. A heat engine performs  $100 \text{ J}$  of work and at the same time rejects  $400 \text{ J}$  of heat energy to the cold reservoirs. What is the efficiency of the engine? :  
 (a)  $20\%$  (b)  $25\%$  (c)  $4\%$  (d)  $50\%$
30. An ideal gas of  $n$  moles is enclosed in a container at a constant pressure  $p$ . The graph between volume of gas and its absolute temperature is a straight line. What is the gradient of the graph?  
 (a)  $nR/p$  (b)  $nRp$  (c)  $n/Rp$  (d)  $np/R$
31. Which of the following statement is not true about heat engine?  
 (a) All real engines are less efficient than Carnot engine  
 (b) All real engines are less efficient due to friction and heat losses  
 (c) Efficiency of Carnot engine working between same two temperatures, depends on the nature of working substance  
 (d) The larger the temperature difference of two reservoirs, the greater is the efficiency
32. For an ideal gas P.E of the molecules is:  
 (a) Positive (b) Negative (c) Zero (d) Minimum but not zero
33. For an ideal gas change in internal energy is directly proportional to:  
 (a) Temperature (b) Pressure (c) Volume (d) Change in temperature

Sr.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
Ans:	b	b	c	a	d	c	c	a	c	a	a	c	c	d

34. If root mean square velocity of a gas at temperature  $27^\circ\text{C}$  is  $v$ . Then root mean square velocity of gas at temperature  $327^\circ\text{C}$  will be:

- (a)  $v$  (b)  $2v$  (c)  $\sqrt{2}v$  (d)  $4v$

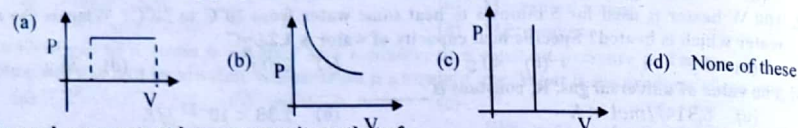
35. If helium gas is enclosed in a cylinder then molecules will have?

- (a) Translational K.E (b) Rotational K.E  
(c) Vibrational K.E (d) All of these

36. Internal energy of an ideal gas at temperature  $T$  is  $U$ , then is internal energy at temperature  $4T$  will be:

- (a)  $U$  (b)  $2U$  (c)  $U/2$  (d)  $4U$

37. In which of the following graph work done is zero.



38. General gas constant have same units as that of:

- (a) Boltzmann constant (b) Heat capacity  
(c) Molar specific heat (d) Internal energy

39. If  $50\text{ J}$  work is done on the system and at same time  $100\text{ J}$  heat is added to the system, then change in internal energy of the system will be:

- (a)  $50\text{ J}$  (b)  $150\text{ J}$  (c)  $-50\text{ J}$  (d)  $-150\text{ J}$

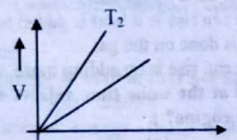
40. For which of the following process then its change in internal energy will be:

- (a) Isothermal (b) Adiabatic (c) Isobaric (d) Isochoric

41. Heating food in pressure cooker is an example of:

- (a) Isothermal process (b) Adiabatic process  
(c) Isobaric process (d) Isochoric process

42. If two different gases undergo isothermal expansion at temperature  $T_1$  and  $T_2$  as shown in the figure below then:



- (a)  $T_1 = T_2$  (b)  $T_1 > T_2$  (c)  $T_1 < T_2$  (d) Cannot be determined

43. When water is heated isothermally, then its heat capacity will be:

- (a) Zero (b) Infinite (c)  $4.18\text{ JK}^{-1}$  (d)  $4180\text{ JK}^{-1}$

44. The difference between molar specific heat of a gas at constant pressure and molar specific heat at constant volume is: (in SI units)

- (a)  $1.38 \times 10^{-23}$  (b)  $8.314$  (c)  $6.02 \times 10^{23}$  (d) Zero

45. If  $\gamma$  is ratio of molar specific heat of a gas at constant pressure to molar specific heat of gas at constant volume and  $R$  is general gas constant then which of the following relation is true?

- (a)  $C_v = \frac{R}{\gamma - 1}$  (b)  $\frac{\gamma R}{\gamma - 1}$  (c)  $C_p - C_v = R$  (d) All of these

46. If  $100\text{ J}$  work is done on the system during an adiabatic compression then heat added to system and change in internal energy will be:

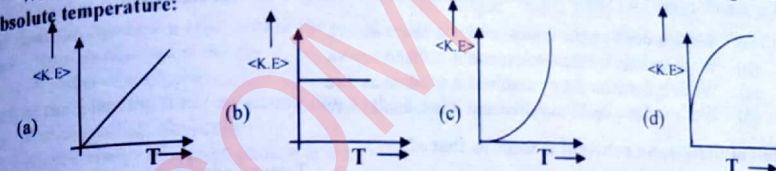
- (a)  $0, 100\text{ J}$  (b)  $-50\text{ J}, -50\text{ J}$  (c)  $0, -100\text{ J}$  (d)  $50\text{ J}, 50\text{ J}$

Sr.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	c	a	c	c	c	b	a	c	c	b	b	d	a

47. For hydrogen gas  $C_p - C_v = a$  and for oxygen gas  $C_p - C_v = b$  then the relation between  $a$  and  $b$  will be:

- (a)  $a = b$  (b)  $a < b$  (c)  $a > b$  (d)  $a = 4b$

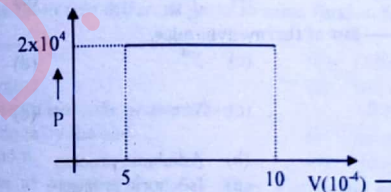
48. Which of the following graph represents the relationship between average K.E of a gas and absolute temperature:



49. Unit of general gas constant in terms of base units is:

- (a)  $\text{Kgms}^{-2}\text{mol}^{-1}\text{K}^{-1}$  (b)  $\text{Kgm}^2\text{s}^{-2}\text{mol}^{-1}\text{K}^{-1}$  (c)  $\text{Kgm}^2\text{s}^{-3}\text{mol}^{-1}\text{K}^{-1}$  (d)  $\text{Kgm}^2\text{s}^{-2}\text{mol}^{-1}\text{K}^{-1}$

50. When  $50\text{ J}$  heat is added to a gas it undergoes an expansion as shown in the figure below, then the change in internal energy of gas will be:

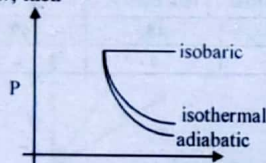


- (a)  $50\text{ J}$  (b)  $100\text{ J}$  (c)  $-50\text{ J}$  (d)  $150\text{ J}$

Sr.	47.	48.	49.
Ans:	a	a	c

## PRACTICE TEST NO. 3

- Which of the following is not a state function?  
(a) Work done (b) Internal energy (c) Gravitational P.E (d) None of these
- A gas undergoes an expansion then which of the following is correct statement:  
(a) Work is done on the system and it is taken as -ve  
(b) Work is done by the system and it is taken as -ve  
(c) Work is done on the system and it is taken as +ve  
(d) Work is done by the system and it is taken as +ve
- Unit of Boltzmann constant is same as that of:  
(a) Specific heat (b) Heat capacity (c) Temperature coefficient of resistance (d) Decay constant
- Root mean square velocity of a gas is given as:  
(a)  $\sqrt{\frac{3KT}{m}}$  (b)  $\sqrt{\frac{3PV}{M}}$  (c)  $\sqrt{\frac{3RT}{M}}$  (d) All of these
- Metabolism is an example of \_\_\_\_\_ law of thermodynamics.  
(a) Zeroth (b) 1<sup>st</sup> (c) 2<sup>nd</sup> (d) None of these
- If a gas expand isothermally then:  
(a)  $\Delta U = 0$  (b)  $Q = 0$  (c)  $W = 0$  (d) None of these
- Cloud formation is an example of:  
(a) Isothermal process (b) Adiabatic process  
(c) Isobaric process (d) Isochoric process
- If  $W_1$ ,  $W_2$  and  $W_3$  are work done in isothermal, adiabatic and isobaric process respectively as shown in figure below, then



- $W_1 = W_2 = W_3$  (b)  $W_1 < W_2 < W_3$  (c)  $W_2 < W_1 < W_3$  (d)  $W_3 < W_2 < W_1$
- Specific heat of a substance depends upon:  
(a) Heat added to system and change in temperature (b) Amount of substance  
(c) Nature of substance (d) All of these
- $PV^\gamma = \text{constant}$  is true for:  
(a) Isothermal process (b) Isobaric process  
(c) Isochoric process (d) Adiabatic process
- For an ideal gas if  $C_v = \frac{5R}{2}$  and  $C_p = \frac{7R}{2}$  then the gas is:  
(a) Mono atomic (b) Diatomic (c) Polyatomic (d) None of these
- The value of  $\gamma$  for mono atomic gas is:  
(a)  $\frac{5}{3}$  (b)  $\frac{7}{5}$  (c)  $\frac{9}{7}$  (d)  $\frac{11}{9}$
- Which of this is constant in isochoric process?  
(a) Volume (b) Work done (c) Entropy (d) Internal energy

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Ans:	a	d	b	d	b	a	b	c	c	d	b	a	a

The first law of thermodynamics can be stated as:

- $Q = \Delta U + W$  (b)  $Q + \Delta U = W$  (c)  $Q = \Delta U - W$  (d)  $Q = \Delta U \times W$
- Two identical gases expand (i) isothermally (ii) adiabatically  
(a) Isothermal process (b) Adiabatic process  
(c) Neither of them (d) Equal in both cases
- What does the constant  $n$  represent in the equation of state for an ideal gas  $PV = nRT$ ?  
(a) Number of atoms in the gas (b) Number of moles of the gas  
(c) Number of nucleons (d) Number of molecules of gas
- Which of the following is not an assumption of the kinetic model of an ideal gas?  
(a) Particles collide elastically  
(b) Kinetic energy of a given particle is same  
(c) The duration of collision between molecules is very short  
(d) Intermolecular potential energy of the molecules is zero
- Which of this is constant in adiabatic process  
(a) Total heat (b) Entropy  
(c) Work done (d) Both a and c
- If the system goes from two different paths to same final state, then change in internal energy for both systems is \_\_\_\_\_  
(a) Same (b) Different  
(c) May be same (d) Not enough information
- When heat is given to isobaric process then:  
(a) Work is done by the gas (b) Internal energy of gas decrease  
(c) Both a and b (d) None of them
- A monatomic gas at pressure  $P$  and Volume  $V$  expands isothermally to volume  $2V$  and then adiabatically to volume  $16V$ . The final pressure is: ( $\gamma = \frac{5}{3}$ )  
(a)  $16P$  (b)  $64P$  (c)  $32P$  (d)  $P/64$
- Internal energy of an ideal gas depends upon  
(a) Pressure (b) Volume (c) temperature (d) all
- Slope of adiabatic(ks) and isothermal(kt) curve related as:  
(a)  $K_s = \gamma kt$  (b)  $K_s = kt/\gamma$  (c)  $ks = kt$  (d)  $ks = 2kt$
- What is the internal energy change in system that has absorbed 800J of heat and work done is 500J?  
(a) 1300J (b) 550J (c) 600J (d) 300J
- In SONAR we use:  
(a) Water waves (b) Sound waves  
(c) Ultrasound waves (d) Ultraviolet rays
- In thermodynamics first law is related with  
(a) Pressure conservation (b) Entropy conservation  
(c) Temperature conservation (d) Energy conservation
- Temperature is defined by  
(a) First law of thermodynamics  
(b) Zeroth law of thermodynamics  
(c) Second law of thermodynamics  
(d) Third law of thermodynamics
- Which one of the following is not the unit of heat?  
(a) Calorie (b) Joule (c) Watt.sec (d) Watt
- If a system undergoes a cyclic process then:  
(a)  $W=0$  (b)  $Q=0=W$  (c)  $\Delta U = 0$  (d)  $W=0$

Sr.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
Ans:	a	a	b	b	d	a	a	a	c	a	d	c	d	b	d	c

30. If 110 J heat is added to the system and 40 J work is done, then change internal energy:

- (a) 70 J (b) 150 J (c) 190 J (d) 180 J

31. A gas expands from  $V_1$  to  $V_2$ . The amount of work done is greater in:

- (a) Adiabatic (b) Isobaric (c) Isochoric (d) Isothermal

32. "The amount of heat transformer required to raise the temperature of one mole of the gas through 1 K at constant pressure" is called:

- (a) The molar specific heat at constant pressure (b) Molar heat capacity pressure  
(c) Specific latent heat (d) Specific heat capacity

33. P-V diagram of a diatomic gas is straight line parallel to volume axis. What is the molar heat capacity of the gas in the process?

- (a)  $5R/2$  (b)  $1.5R$  (c)  $7R/2$  (d)  $4R/3$

34. Which of the following is the expression of root mean square speed of a gas having  $n$  number of molecules contained in the container?

- (a)  $\sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{N}}$  (b)  $\frac{v_1^2 + v_2^2 + \dots + v_n^2}{N}$  (c)  $\sqrt{\frac{v_1 + v_2 + \dots + v_n}{N}}$  (d)  $\frac{v_1 + v_2 + \dots + v_n}{N}$

35. Which of the following of thermodynamics gives definition of internal energy

- (a) Zeroth law (b) 1<sup>st</sup> law  
(c) 2<sup>nd</sup> law (d) None of these

36. Which of the following is expression of mean square speed of ' $N$ ' gas molecules contained in a cylinder?

- (a)  $\frac{v_1 + v_2 + \dots + v_n}{N}$  (b)  $\frac{v_1^2 + v_2^2 + \dots + v_n^2}{N}$  (c)  $\sqrt{\frac{v_1 + v_2 + \dots + v_n}{N}}$  (d)  $\sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{N}}$

37. What is the value of universal gas constant?

- (a)  $8314 \text{ Jmol}^{-1}\text{K}^{-1}$  (b)  $83.14 \text{ Jmol}^{-1}\text{K}^{-2}$  (c)  $831.4 \text{ Jmol}^{-1}\text{K}^{-1}$  (d)  $8.314 \text{ Jmol}^{-1}\text{K}^{-2}$

38. A gas sample contains three molecules each having speed  $1 \text{ ms}^{-1}$ ,  $2 \text{ ms}^{-1}$ ,  $3 \text{ ms}^{-2}$ . What is the mean square speed?

- (a)  $14/3 \text{ m/s}$  (b)  $6 \text{ m/s}$  (c)  $2 \text{ m/s}$  (d)  $\sqrt{14/3} \text{ m/s}$

39. A gas containing ' $N$ ' number of molecules of a gas having mass of each molecules ' $m$ ' is in a cubic container having length of each side ' $a$ '. What is the density of gas contained in cube?

- (a)  $N/a^2$  (b)  $Nm/a^3$  (c)  $m/a^3$  (d)  $Na^3/m$

40. In 'General Gas Equation  $PV = nRT$ ', ' $n$ ' represents the number of moles of gas. Which of the following represents the relation of ' $n$ '?

- (a)  $n = NN_A$  (b)  $n = N_A/N$  (c)  $n = N/N_A$  (d)  $n = N + N_A$

41. Two samples of gases '1' and '2' are taken at same temperature and pressure but the ratio of number of their volume is  $V_1:V_2 = 2:3$ . What is the ratio of number of moles of the gas sample?

- (a) 3:2 (b)  $\sqrt{2}:\sqrt{3}$  (c) 4:9 (d) 2:3

42. If ' $Q$ ' is the amount of heat supplied to a system and ' $W$ ' is the work done, then change in internal energy can be defined as:

- (a)  $Q/W$  (b)  $W/Q$  (c)  $Q - W$  (d)  $1 + Q/W$

Sr.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.
Ans:	a	b	a	c	a	b	b	d	a	b	c	d	c

43. Root mean square velocity of a gas having pressure ' $P$ ' and density ' $\rho$ ' is given by:

- (a)  $\sqrt{\frac{3P}{\rho}}$  (b)  $\frac{3P}{\rho}$  (c)  $\sqrt{\frac{3P}{\rho}}$  (d)  $\frac{3P}{\rho}$

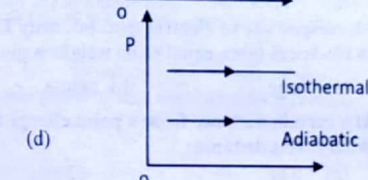
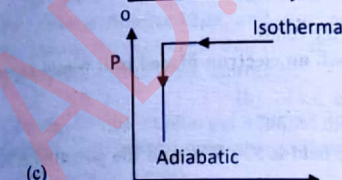
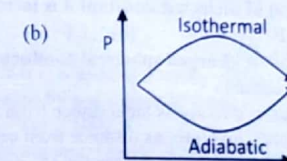
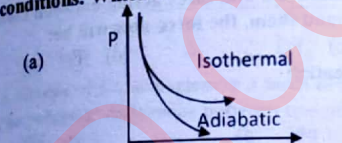
44. The relation  $\frac{R}{N_A} = 1.38 \times 10^{-23} \text{ JK}^{-1}$  in a gas law is known as:

- (a) Avogadro's constant (b) Newton's constant  
(c) Charles constant (d) Boltzmann's constant

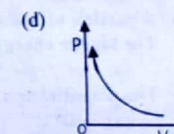
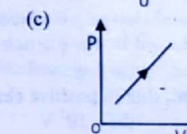
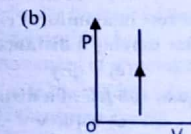
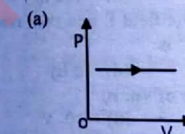
45. The relation ' $PV = nRT$ ' shows which law of physics:

- (a) Charles Law (b) Avogadro's Law  
(c) Newton's Constant (d) Ideal Gas Law

46. Pressure volume graph of two system 'A' and 'B' are plotted under isothermal and adiabatic conditions. Which of the following observation of graph represents the two systems?



47. Which of the following curve is an isotherm?



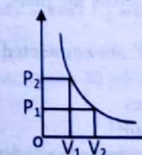
48. First law of thermodynamics under adiabatic conditions can be mathematically written as:

- (a)  $Q = W$  (b)  $Q = U + W$  (c)  $Q = \Delta U$  (d)  $W = -\Delta U$

49. What is the factor upon which change in internal energy of an ideal gas depends?

- (a) Change in volume (b) Change in temperature and volume  
(c) Change in temperature (d) Path followed to change internal energy

50. What will be the mathematical form of thermodynamics for a system whose variation of volume by pressure is shown?



- (a)  $Q = U$  (b)  $Q = U/W$  (c)  $U = W$  (d)  $Q = W$

Sr.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	d	d	a	d	c	c	d

## UNIT 06 &gt;&gt;

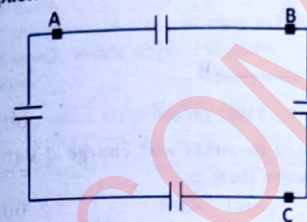
## ELECTROSTATICS

## PRACTICE TEST NO. 1

- A soap bubble is given a negative charge, then its radius:
  - Decreases
  - Increases
  - Remains unchanged
  - Nothing can be predicted
- Two charges  $q_1$  and  $q_2$  are placed in a vacuum at a distance  $d$  and force acting between them is  $F$ . If a medium of dielectric constant 4 is introduced around them, the force now will be:
  - $4F$
  - $2F$
  - $F/2$
  - $F/4$
- Inside a hollow charged spherical conductor, the potential:
  - Is constant
  - Varies directly as the distance from the centre
  - Varies inversely as distance from centre
  - Varies inversely as square of the distance from the centre
- The magnitude of electric field intensity  $E$  is such that, an electron placed in it would experience an electrical force equal to its weight is given by:
  - $mge$
  - $mg/e$
  - $e/mg$
  - $\frac{e^2}{m^2g}$
- At a certain distance from a point charge the electric field is  $500 \text{ V/m}$  and the potential is  $3000 \text{ V}$ . What is this distance:
  - $6 \text{ m}$
  - $12 \text{ m}$
  - $36 \text{ m}$
  - $144 \text{ m}$
- A particle of mass  $m$  and charge  $q$  is placed at rest in a uniform electric field  $E$  and then released. The kinetic energy attained by the particle after moving a distance ' $Y$ ' is:
  - $qEy^2$
  - $qE^2y$
  - $qEy$
  - $q^2Ey$
- The potential at a point, due to positive charge of  $100 \mu\text{C}$  at a distance of  $9 \text{ m}$  is:
  - $10^4 \text{ V}$
  - $10^5 \text{ V}$
  - $10^6 \text{ V}$
  - $10^7 \text{ V}$
- A capacitor is charged by using a battery which is then disconnected. A dielectric slab is the slipped between the plates, which results in:
  - Reduction of charge on the plates and increase of potential difference across the plates
  - Increase in potential difference across the plate, reduction in stored energy, but no change in the charge on the plate
  - Decrease in potential difference across the plate, reduction in stored energy, but no change in the charge on the plate
  - Decrease in potential difference across the plate, increase in stored energy, but no change in the charge on the plate
- If three capacitors each of capacity  $1 \mu\text{F}$  are connected in such a way that the resultant capacity is  $1.5 \mu\text{F}$ , then:
  - All the three are connected in series
  - All the three are connected in parallel
  - Two of them are in parallel and connected in series to the third
  - Two of them are in series and then connected in parallel to the third

Sr.	1	2	3	4	5	6	7	8	9
Ans:	b	d	a	b	a	c	b	c	d

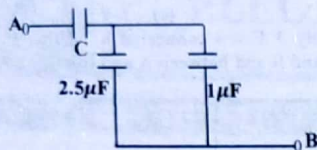
- A hollow metal sphere of radius  $5 \text{ cm}$  is charged so that the potential on its surface is  $10 \text{ V}$ . The potential at the centre of the sphere is:
  - $0 \text{ V}$
  - $10 \text{ V}$
  - $5 \text{ V}$
  - $20 \text{ V}$
- Four capacitors of each of capacity  $3 \text{ F}$  are connected as shown in the figure. The ratio of equivalent capacitance between A and B and between A and C will be:
  - $4:3$
  - $3:4$
  - $2:3$
  - $3:2$



- A charge of  $5 \text{ C}$  experiences a force of  $5000 \text{ N}$ . When it is kept in a uniform electric field. What is the potential difference between two points separated by a distance of  $1 \text{ cm}$ :
  - $10 \text{ V}$
  - $250 \text{ V}$
  - $1000 \text{ V}$
  - $2500 \text{ V}$
- Two electric charges  $12 \mu\text{C}$  and  $-6 \mu\text{C}$  are placed  $20 \text{ cm}$  apart in air. There will be a point P on the line joining these charges and the region between them, at which the electric potential is zero. The distance from  $-6 \mu\text{C}$  charge is:
  - $6.6 \text{ cm}$
  - $13.4 \text{ cm}$
  - $10 \text{ cm}$
  - $5 \text{ cm}$
- Consider two point charges of equal magnitude and opposite sign separated by a certain distance. The neutral point due to them:
  - Does not exist
  - Will be in mid way between them
  - Lies on the perpendicular bisector of line joining the two
  - Will be closer to the negative charge
- A point charge is kept at the centre of a metallic insulated spherical shell. Then:
  - Electrical field out side the sphere is zero
  - Electric field inside the sphere is zero
  - Electrical potential inside the sphere is zero
  - None of these
- The dielectric constant  $K$  of an insulator can't be:
  - $3$
  - $6$
  - $8$
  - $\infty$
- Work done by an external agent in separating the parallel plate capacitor is:
  - $CV$
  - $\frac{1}{2}C^2V$
  - $\frac{1}{2}CV^2$
  - None of these
- Two capacitors connected  $C_1$  and  $C_2$  are connected in series and potential difference  $V$  is applied across it. Then the potential difference across  $C_2$  will be:
  - $V \frac{C_2}{C_1 + C_2}$
  - $V \frac{C_1 + C_2}{C_1}$
  - $V \frac{C_2}{C_1 + C_2}$
  - $V \frac{C_1}{C_1 + C_2}$
- A parallel plate condenser has a capacitance  $50 \mu\text{F}$  in air and  $110 \mu\text{F}$  when immersed in an oil. The dielectric constant ' $K$ ' of the oil is:
  - $0.45$
  - $0.55$
  - $1.10$
  - $2.20$
- For a positive charge, the electric field lines are:
  - Directed radially outward
  - Directed along zig-zag path
  - Directed radially inward
  - Any of these

Sr.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans:	b	a	a	a	a	b	d	c	d	d	a

21. The equivalent capacitance between A and B in the figure is  $1\mu\text{F}$ . Then the value of capacitance C is:



- (a)  $1.4\mu\text{F}$  (b)  $2.5\mu\text{F}$  (c)  $3.5\mu\text{F}$  (d)  $1.2\mu\text{F}$
22. Two point particles, in with charge  $8 \times 10^{-9} \text{ C}$  and the other with charge  $-2 \times 10^{-9} \text{ C}$ , are separated by 4 m. The electric field in  $\text{N C}^{-1}$  midway between them is:  
(a)  $9 \times 10^9$  (b)  $36 \times 10^9$  (c) Zero (d)  $2.25 \times 10^9$
23. The correct expression for electric potential at a distance  $r$  due a point charge  $Q$  is:  
(a)  $V = \frac{kQ}{r}$  (b)  $V = \frac{kE}{r}$  (c)  $V = \frac{kr}{Q}$  (d)  $\vec{V} = \frac{kQ}{r} \hat{r}$
24. A charge of  $0.01 \text{ C}$  accelerated through potential difference of  $1000 \text{ V}$  acquires K.E?  
(a)  $10 \text{ J}$  (b)  $200 \text{ J}$  (c)  $100 \text{ J}$  (d)  $400 \text{ eV}$
25. The potential difference between two metal plates is halved and distance between them is doubled, the value of electric field strength between them becomes:  
(a) Half of the original (b) Same as original  
(c) Double of the original (d) One-fourth of the original
26. The units of  $\epsilon_r$  are:  
(a)  $\text{C}^2 \text{ N}^{-1} \text{ m}^{-2}$  (b)  $\text{N C}^2 \text{ m}^{-2}$  (c)  $\text{N m}^2 \text{ C}^{-2}$  (d) Unit-less
27. The electric field between oppositely charged infinite sheets of plates is given by:  
(a)  $E = \left(\frac{\sigma}{2\epsilon_0}\right)$  (b)  $E = \left(\frac{2\sigma}{\epsilon_0}\right)$  (c)  $E = \left(\frac{\sigma}{\epsilon_0}\right)$  (d) Zero
28. The potential gradient between the two charged plates having separation of  $0.5 \text{ cm}$  and potential difference of  $12 \text{ volt}$  is:  
(a)  $240 \text{ N C}^{-1}$  (b)  $2.4 \text{ N C}^{-1}$  (c)  $24 \text{ N C}^{-1}$  (d)  $2400 \text{ N C}^{-1}$
29. The capacity of parallel plate capacitor is  $5 \mu\text{F}$ . When a glass plate is placed between the plates of the condenser, its potential difference reduces to  $\frac{1}{5}$  of the original value. The value of dielectric constant of glass is:  
(a) 1.2 (b) 10 (c) 5 (d) 40
30. By placing the dielectric between the plates of an isolated charged capacitor, the energy stored:  
(a) Remains same (b) Increases (c) Becomes zero (d) Decreases
31. The quantity  $\frac{1}{2} \epsilon_0 \epsilon_r E^2$  has significance of:  
(a) Energy / capacitance (b) Energy / volume  
(c) Energy / coulomb (d) Energy / volt
32. Three capacitors of capacitance  $2 \mu\text{F}$  each are connected in series to a power supply of  $6 \text{ volt}$ . The voltage across each capacitor is:  
(a)  $1 \text{ V}$  (b)  $3 \text{ V}$  (c)  $2 \text{ V}$  (d)  $6 \text{ V}$
33. If applied voltage to a capacitor becomes half then capacitance becomes:  
(a) Double (b) Half (c) Four time (d) Remains same
34. A capacitors may be considered as a device for:  
(a) Storing electrical energy (b) Decreasing resistance  
(c) Increasing resistance (d) Storing Chemical energy

Sr.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Ans:	a	d	a	a	d	d	a	d	c	d	b	b	d	a

35. The expression of energy density for a capacitor is:

- (a)  $U = \frac{1}{2} \epsilon_0 \epsilon_r E^2$  (b)  $U = \frac{1}{2} \epsilon_0 \epsilon_r / E^2$  (c)  $U = \frac{1}{2} \epsilon_0 \epsilon_r E$  (d)  $U = \frac{1}{2} E^2 / \epsilon_0 \epsilon$

36. The electronic flashguns in cameras is an application of:  
(a) Coulomb's law (b) Capacitor  
(c) Gauss's law (d) Diode

37. Three objects are brought close to each other, two at a time, when objects A and B are brought together, they repel. When objects B and C are brought together, they also repel. Which of the following are true?

- (a) Objects A and C possess charges of the same sign, but not B  
(b) Objects A and C possess charges of opposite sign  
(c) All three objects possess charges of the same sign  
(d) One object neutral

38. Negative of potential gradient is equal to

- (a) Electric intensity (b) Electric flux (c) Magnetic intensity (d) Magnetic flux

39. A  $18.0 \text{ V}$  battery is connected to a capacitor, resulting in  $27.0 \mu\text{C}$  of charge stored on the capacitor. How much energy is stored in the capacitor?

- (a)  $2.43 \times 10^{-4} \text{ J}$  (b)  $2.86 \times 10^{-4} \text{ J}$   
(c)  $2.43 \times 10^{-2} \text{ J}$  (d)  $2.86 \times 10^{-2} \text{ J}$

40. You have three capacitors, each of  $2\mu\text{C}$ . In which of the following combinations of the three capacitors, the resultant capacitance is  $3\mu\text{C}$ ?

- (a) All three capacitors in series  
(b) Two capacitors are in series, one in parallel  
(c) Two capacitors are in parallel, one in series  
(d) All three capacitors in parallel

41. Which one is the correct statement about selenium?

- (a) Selenium is a good conductor  
(b) Selenium is a good insulator  
(c) Selenium is an insulator in the dark and becomes conductor when exposed to light  
(d) Selenium is an conductor in the dark and becomes insulator when exposed to light

42. What is the formula for Coulomb's law?

- (a)  $F = kq_1q_2/r^2$  (b)  $F = 2kq_1q_2/r^3$  (c)  $F = kq_1/r$  (d)  $F = kq_1/q_2$

43. Electric potential energy per unit charge is

- (a) Electric flux (b) Electric potential (c) Electric field (d) Electric intensity

44. If a particle have charge  $q$  is accelerated through a potential difference  $V$ , then energy acquired by the particle is:

- (a)  $Vq^2$  (b)  $2qV$  (c)  $\frac{qV}{2}$  (d)  $qV$

45. Electric intensity and electric potential are related as:

- (a) Electric field intensity is equal to the negative of the gradient of electric potential  
(b) Electric field intensity is equal to the gradient of electric potential  
(c) Electric field intensity is equal to the square of the gradient of electric potential  
(d) Electric field intensity is equal to the twice of the gradient of electric potential

46. A capacitor stores  $5.3 \times 10^{-5} \text{ C}$  of charge when connected to a  $6.0 \text{ V}$  battery. How much charge does the capacitor store when connected to a  $9.0 \text{ V}$  battery?

- (a)  $79.5 \mu\text{C}$  (b)  $35.3 \mu\text{C}$  (c)  $79.5 \text{ pC}$  (d)  $35.3 \text{ pC}$

Sr.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	a	b	a	a	a	b	c	a	b	d	a	a

47. Electric field lines  
 (a) never cross each other (b) Can cross each other  
 (c) Depends on shape of charge (d) Not enough information
48. What is the acceleration of an object having charge  $2\mu\text{C}$  and mass  $2\text{ g}$  moving through electric field strength  $20\text{ N/C}$ ?  
 (a)  $4\text{ cm/s}^2$  (b)  $2\text{ cm/s}^2$  (c)  $40\text{ cm/s}^2$  (d)  $20\text{ cm/s}^2$
49. Two point charges attract each other with an electric force of magnitude  $F$ . If the charge on one of the particles is reduced to one half its original value and the distance between the particles is doubled, what is the resulting magnitude of the electric force between them?  
 (a)  $F$  (b)  $F/2$  (c)  $F/4$  (d)  $F/8$
50. Electric charge on an object is measured as  $5\text{ micro coulombs}$ . How the value of this charge can be expressed in terms of base units:  
 (a)  $5 \times 100\text{ ampere second}$  (b)  $5 \times 10^{-6}\text{ coulomb second}$   
 (c)  $5 \times 10^{-6}\text{ ampere second}$  (d)  $5 \times 100\text{ coulomb second}$

## PRACTICE TEST NO. 2

1. The electric potential at any point in an electric field can be defined as:  
 (a) Work done in bringing a unit positive charge from infinity to that point  
 (b) Work done in bringing a unit positive charge from infinity to that point while keeping the charge in equilibrium.  
 (c) Work done in bringing a unit negative charge from infinity to that point while keeping the charge in equilibrium.  
 (d) Work done in bringing a unit negative charge from infinity to that point while keeping the charge in equilibrium
2. The number of electrons taken out from a body to produce  $1\text{ coulomb}$  of charge will be:  
 (a)  $6.25 \times 10^{18}$  (b)  $625 \times 10^{18}$  (c)  $6.023 \times 10^{23}$  (d) None of these
3. An electron is held within electric field. What happens when electron is released?  
 (a) It moves in the direction of electric field  
 (b) It accelerates in the direction of electric field  
 (c) It moves in the direction opposite to electric field  
 (d) It accelerates in the direction opposite to electric field
4. A capacitor of capacitance  $C$  is connected with resistance  $R$ . The time constant of the circuit of the circuit would be:.....  
 (a)  $RC$  (b)  $R/C$  (c)  $e^{\wedge}RC$  (d)  $R+C$
5. The electric potential difference between two points A and B in an electric field can be defined as:  
 (a) Work done in carrying a unit positive charge from infinity to B while keeping the charge in equilibrium  
 (b) Work done in carrying a unit positive charge from A to infinity while keeping the charge in equilibrium  
 (c) Work done in carrying a unit positive charge from A to B while keeping the charge in equilibrium  
 (d) Work done in carrying a unit positive charge from A to B
6.  $1\text{ microvolt}$  is:  
 (a)  $1 \times 10^{-3}\text{ V}$  (b)  $1 \times 10^{-4}\text{ V}$  (c)  $1 \times 10^{-5}\text{ V}$  (d)  $1 \times 10^{-6}\text{ V}$

Sr.	47.	48.	49.	50.	1.	2.	3.	4.	5.	6.
Ans:	a	a	d	c	b	a	c	a	c	d

7. You have three capacitors and a battery, in which of the following combinations of the three capacitors is the maximum possible energy stored when the combination is attached to the battery?  
 (a) In parallel (b) In series  
 (c) Either way because both combination have the same capacitance  
 (d) We cannot determine, because presence of resistance in the circuit determines capacitance
8. You have three capacitors, each of  $2\mu\text{C}$ . In which of the following combination of the three capacitors, the resultant capacitance is maximum?  
 (a) All three capacitors in series  
 (b) Two capacitors are in series, one in parallel  
 (c) Two capacitors are in parallel, one in series  
 (d) All three capacitors in parallel
9. Electric field lines provide information about:  
 (a) Field strength (b) Direction  
 (c) Nature of charge (d) All of these
10. If two point charges of charge  $q_1$  and  $q_2$  are placed at distance  $d$ . The force between them is proportional to: .....  
 (a)  $q_1 + q_2$  (b)  $q_1 - q_2$  (c)  $q_1 / q_2$  (d)  $q_1 \times q_2$
11. Two point charges are at the distance  $d$ . If force between these two charges is  $F$ , then what is the force between charges when the distance between them is  $3d$ ?  
 (a)  $\frac{F}{3}$  (b)  $\frac{F}{9}$  (c)  $\frac{3F}{2}$  (d)  $\frac{9F}{2}$
12. A test charge of  $23\mu\text{C}$  is at a point P where an external electric field is directed to the left and has a magnitude of  $3.1 \times 10^6\text{ N/C}$ . If the test charge is replaced with another test charge of  $13\mu\text{C}$ , What happens to the external electric field at P?  
 (a) It remain same  
 (b) It reverse direction  
 (c) It change in a way that cannot be determined  
 (d)  $3.1 \times 10^5\text{ N/C}$
13. The minimum charge on an object cannot be less than:  
 (a)  $1.6 \times 10^{-19}\text{C}$  (b)  $9 \times 10^9\text{C}$   
 (c)  $9.1 \times 10^{-31}\text{C}$  (d)  $1.6 \times 10^{-27}\text{C}$
14.  $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots + \frac{1}{C_n}$  is the combination in  
 (a) Series (b) Parallel (c) Both of them (d) None of them
15. You have three capacitor, each of  $2\mu\text{C}$ . In which of the following combinations of the three capacitor, the resultant capacitance is  $6\mu\text{C}$ ?  
 (a) All three capacitors in series (b) Two capacitors are in series, one in parallel  
 (c) Two capacitors are in parallel, one in series (d) All three capacitors in parallel
16. Electric field lines due to a positive charge are: ...  
 (a) Always horizontal (b) Always vertical  
 (c) Radially towards the charge (d) Radially away from the charge
17. The potentials of the two plates of a capacitor are  $+12.5\text{ V}$  and  $-12.5\text{ V}$ . The charge on one of the plates is  $60\text{ C}$ . The capacitance of the capacitor is:  
 (a)  $2.4\text{ F}$  (b)  $3.5\text{ F}$  (c)  $4.2\text{ F}$  (d)  $1.7\text{ F}$

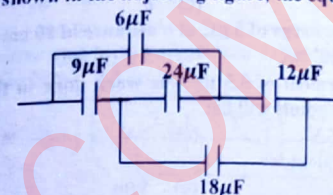
Sr.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Ans:	a	d	d	d	b	a	a	a	d	d	a

18. A capacitor which has a capacitance of 5 farad will:
- Be fully charged in 1 second by current of 1 ampere
  - Store 5 coulomb of charge at potential difference of 1 volt
  - Gain 1 joule of energy when 1 coulomb of charge is stored on it
  - Discharge in 1 s when connected across a resistor of resistance 2 ohm
19. The automobile wind shield wipers works on the principle of \_\_\_\_\_?
- Electricity
  - Battery
  - Charging and discharging of capacitor
  - Charging and discharging of inductor
20. 100 V potential difference is applied across the plates of  $1 \mu\text{F}$  capacitor. What is the energy stored capacitor?
- 0.5 mJ
  - 5 mJ
  - 0.05 mJ
  - 50 mJ
21. A capacitor acts as blocking elements when applied signal is:
- A.C
  - Sinusoidal
  - D.C
  - All of these
22. When two capacitors of same capacitance are connected in parallel and then in series (same battery is connected across combination in both cases), the energy stored:
- Is greater for series combination
  - Is greater for parallel combination
  - Is same for both combination
  - Is double in series combination than parallel combination
23. A glass plate is put within the plates of a charged parallel plate condenser. Which of the following quantities does not change?
- Energy stored
  - Charge
  - Electric intensity
  - Capacity
24. A  $4 \mu\text{F}$  capacitor is charged to 400 V and then its plates are joined through a resistance of  $2\text{k}\Omega$ . The heat produced in the resistance is:
- 1.28 J
  - 0.64 J
  - 0.32 J
  - 0.16 J
25. The work done in moving a charge along an equipotential surface is:
- Depends on the path taken
  - Equal to zero
  - Greater than zero
  - Negative
26. The force on proton in electric field of magnitude  $10^6 \text{ N C}^{-1}$  is:
- $1.6 \times 10^{-15} \text{ N}$
  - $1.6 \times 10^{-13} \text{ N}$
  - $1.6 \times 10^9 \text{ N}$
  - $1.6 \times 10^{13} \text{ N}$
27. An alpha particle has twice the charge of a proton. Two protons separated by a distance 'd' exert a force 'F' on each other. What must be the separation between two alpha particles so that they also exert a force 'F' on each other?
- 2d
  - $\sqrt{2}d$
  - d/2
  - $d/\sqrt{2}$
28. The work done on a unit positive charge while moving it from infinity to a point in electric field keeping the charge in equilibrium is called:
- Electric potential
  - Potential difference
  - Electric field intensity
  - Electric force
29. The equipotential lines are always \_\_\_\_\_ to field line:
- Parallel
  - Anti-parallel
  - Perpendicular
  - Inclined at  $60^\circ$
30. The electric field at a certain distance from an isolated alpha particle is  $3.0 \times 10^7 \text{ N C}^{-1}$ . What is the force on an electron when placed at that distance from the alpha particle?
- $4.8 \times 10^{-12} \text{ N}$
  - $3.0 \times 10^7 \text{ N}$
  - $2.6 \times 10^{13} \text{ N}$
  - $6.0 \times 10^7 \text{ N}$
31. The ratio of the electric force between two protons to that between two electrons separated by same distance is of the order of:
- $10^{42}$
  - $10^{36}$
  - $10^{39}$
  - 1

Sr.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
Ans:	b	c	b	c	b	b	c	b	b	a	a	c	a	d

32. What is true about electric field lines:
- No two lines can cross each other
  - Lines are closer where field is weak
  - Tangent to field line gives direction of electric field
  - Both A and C

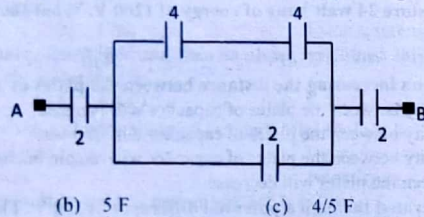
33. In the connections shown in the adjoining figure, the equivalent capacity between A and B will be:



- $10 \mu\text{F}$
  - $69 \mu\text{F}$
  - $15 \mu\text{F}$
  - $1.2 \mu\text{F}$
34. Two capacitor of capacity of  $0.3\mu\text{F}$  and  $0.6 \mu\text{F}$  respectively are connected in series. The combination is connected across a potential of 6V. The ratio of energies stored by the capacitors will be:
- $\frac{1}{2}$
  - 2
  - $\frac{1}{4}$
  - 4
35. A capacitor is used to store 24 watt hour of energy at 1200 V. What should be the capacitance of capacitor?
- 120 mF
  - $120 \mu\text{F}$
  - $24 \mu\text{F}$
  - 24 mF
36. The true statement is, on increasing the distance between the plates of a parallel plate capacitor:
- Electric intensity between the plates of capacitor will increase
  - Electric intensity between the plates of capacitor will decrease
  - Electric intensity between the plates of capacitor will remain unchanged
  - The P.D between the plates will decrease
37. An  $\alpha$ -particle is accelerated through a potential difference of 200 V. The increase in its K.E is:
- 100 eV
  - 200 eV
  - 800 eV
  - 400 eV
38. Electric field intensity at a point in between two parallel sheets with like charges of same surface charge densities is:
- $\frac{\sigma}{2\epsilon_0}$
  - $\frac{\sigma}{\epsilon_0}$
  - $\frac{2\sigma}{\epsilon_0}$
  - Zero
39. An electron enters between two horizontal plates separated by 2mm and having a potential difference of 1000 V. The force on electron is:
- $8 \times 10^{-12} \text{ N}$
  - $8 \times 10^{-14} \text{ N}$
  - $8 \times 10^9 \text{ N}$
  - $8 \times 10^{-14} \text{ N}$
40. Two positive charge of 20 C and Q coulomb are situated at a distance of 60 cm. The neutral point between them is at a distance of 20 cm from the 20 C charge. Charge Q is:
- 30 C
  - 40 C
  - 60 C
  - 80 C
41. The charges on two sphere are  $+7\mu\text{C}$  and  $-5\mu\text{C}$  respectively. They experience a force F. If each of them is given and additional charge of  $-2\mu\text{C}$ , the new force of attraction will be:
- F
  - 2F
  - $\frac{F}{2}$
  - $\frac{F}{\sqrt{2}}$
42. Two capacitors of equal capacity are first connected in parallel and then in series. The ratio of the total capacities in the two cases will be:
- 2:1
  - 1:2
  - 4:1
  - 1:4

Sr.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.
Ans:	d	a	b	a	c	d	b	b	d	a	c

43. The capacity of a parallel plate condenser is  $C$ . Its capacity when the separation between the plates is halved will be:  
 (a)  $4C$  (b)  $2C$  (c)  $C/2$  (d)  $C/4$
44. The capacity of a parallel plate condenser is  $5\mu F$ . When a glass plate is placed between the plates of the conductor, its potential becomes  $1/8^{\text{th}}$  of the original value. The value of dielectric constant will be:  
 (a) 1.6 (b) 5 (c) 8 (d) 40
45. Electric field strength due to a point charge of  $5\mu C$  at a distance of 80 cm from the charge is:  
 (a)  $8 \times 10^4 \text{ N/C}$  (b)  $7 \times 10^4 \text{ N/C}$  (c)  $5 \times 10^4 \text{ N/C}$  (d)  $4 \times 10^4 \text{ N/C}$
46. A charge of 5 C is given a displacement of 0.5 m. The work done in the process is 10 J. The potential difference between the two points will be:  
 (a) 2 V (b) 0.25 V (c) 1 V (d) 25 V
47. The unit of electric field is not equivalent to:  
 (a) N/C (b) J/C (c) V/m (d) J/C-m
48. When the distance between charged particles become halved the force between them becomes:  
 (a) One-fourth (b) Half (c) Double (d) Four times
49.  $F_g$  and  $F_e$  represents gravitational and electrostatic force respectively between electrons situated at a distance 10 cm. The ratio of  $F_g/F_e$  is of the order of:  
 (a)  $10^{42}$  (b) 10 (c) 1 (d)  $10^{-43}$
50. What is the equivalent capacitance between A and B in the given figure?



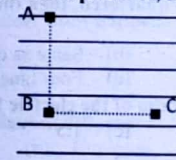
- (a) 4 F (b) 5 F (c)  $4/5$  F (d) 8 F

Sr.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	c	b	a	b	d	d	c

1.  $+2C$  and  $+6C$  charges are repelling each other with a force of 12 N. If each charge is given  $-2C$  of charge, then the value of the force will be:  
 (a) 4 N (attractive) (b) 4 N (repulsive) (c) 8 N (repulsive) (d) Zero
2. Dielectric constant for metal is:  
 (a) Zero (b) Infinite (c) 1 (d) Greater than 1
3. Three equal capacitors, each with capacitance  $C$  are connected as shown in figure. Then the equivalent capacitance between A and B is:



- (a)  $C$  (b)  $3C$  (c)  $C/3$  (d)  $3C/2$
4. The electric field near a conducting surface having a uniform surface charge  $\sigma$  density is given by:  
 (a)  $\frac{\sigma}{\epsilon_0}$  and is parallel to the surface (b)  $\frac{\sigma}{2\epsilon_0}$  and is parallel to the surface  
 (c)  $\frac{\sigma}{\epsilon_0}$  and is normal to the surface (d)  $\frac{\sigma}{2\epsilon_0}$  and is normal to the surface
5. An alpha particle is accelerated through a potential difference of  $10^6$  volt. Its kinetic energy will be:  
 (a) 1 MeV (b) 2 MeV (c) 4 MeV (d) MeV
6. What is the potential energy of the two equal positive point charge of  $1\mu C$  each held 1 m apart in air:  
 (a)  $9 \times 10^{-3} \text{ J}$  (b)  $9 \times 10^{-3} \text{ eV}$  (c) 2 eV/m (d) Zero
7. Figure shows three points A, B and C in a region of uniform electric field  $\vec{E}$ . If  $V_A$ ,  $V_B$  and  $V_C$  represents the electric potential at points A, B and C respectively, then:



- (a)  $V_A = V_B = V_C$  (b)  $V_A = V_B > V_C$  (c)  $V_A = V_B < V_C$  (d)  $V_A > V_B = V_C$
8. Two capacitances of capacity  $C_1$  and  $C_2$  are connected in series and potential difference  $V$  is applied across it. Then the potential difference across  $C_1$  will be:  
 (a)  $V \frac{C_2}{C_1}$  (b)  $V \frac{C_1 + C_2}{C_1}$  (c)  $V \frac{C_2}{C_1 + C_2}$  (d)  $V \frac{C_1}{C_1 + C_2}$
9. A body has  $-80$  micro coulomb of charge. Number of additional electrons in it will be:  
 (a)  $5 \times 10^{20}$  (b)  $5 \times 10^{14}$  (c)  $80 \times 10^{17}$  (d)  $1.28 \times 10^{17}$
10. A particle 'A' has charge  $+q$  and a particle 'B' has charge  $+4q$  with each of them having the same mass  $m$ . When allowed to fall from rest through the same electric potential difference, the ratio of their speed  $\frac{v_A}{v_B}$  will become:  
 (a) 2:1 (b) 1:2 (c) 1:4 (d) 4:1
11. When a proton is accelerated through 1V, then its K.E will be:  
 (a) 1840 eV (b) 1 eV (c) 13.6 eV (d)  $1.6 \times 10^{-19} \text{ eV}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Ans:	d	b	b	d	b	a	b	c	b	a	b

12. A particle of mass 'm' and charge 'q' is associated through a potential difference of V volt. It's energy will be:  
 (a)  $qV$  (b)  $mqV$  (c)  $\frac{q}{mV}$  (d)  $\frac{q}{m}V$
13. An electron having charge 'e' and mass 'm' is moving in a uniform electric field E. Its acceleration will be:  
 (a)  $\frac{e^2}{m}$  (b)  $\frac{E^2 e}{m}$  (c)  $\frac{eE}{m}$  (d)  $\frac{mE}{e}$
14. The capacity of parallel plate capacitor increase with:  
 (a) Decreases to its area (b) Increases to its area  
 (c) Increase of its distance (d) Both b and c
15. When a capacitor remains connected to a battery and dielectric slab is applied between the plates, then:  
 (a) Potential difference between the plates changed  
 (b) Charge flows from battery to the capacitor  
 (c) Electric field between the plates increase  
 (d) Energy store in the capacitor decrease
16. The capacity of air capacitor is  $2\mu F$ . If medium is placed between its plates. The capacity become  $12\mu F$ . The dielectric constant of the medium will be:  
 (a) 5 (b) 3 (c) 4 (d) 6
17. Minimum number of capacitors of  $2\mu F$  capacitance each required to obtain a capacitor of  $5\mu F$  will be:  
 (a) 3 (b) 5 (c) 4 (d) 6
18. A parallel plate condenser is immersed in an oil of dielectric constant 2. The field between the plates is:  
 (a) Increased proportional to 2 (b) Decreased proportional to  $\frac{1}{2}$   
 (c) Increased proportional to  $\sqrt{2}$  (d) Decrease proportional to  $1/\sqrt{2}$
19. The force between two-point charges placed at certain distance is F. If the magnitude of both charges is halved and distance between them is quartered, then the new force between these charges is:  
 (a) Half of the original (b) Same as original  
 (c) Double of the original (d) Four times of the original
20. There are two charges of  $2\mu C$  and  $10\mu C$ . The ratio of the electric force acting on them will be:  
 (a) 1:25 (b) 1:1 (c) 1:5 (d) 5:1
21. Gauss's law can be applied to:  
 (a) Plane surface (b) Any surface (c) Curved surface (d) Closed surface
22. The negative gradient of electric potential is also called:  
 (a) Potential energy (b) Electric potential difference  
 (c) Electric field intensity (d) Electron volt
23. Two charges are placed in vacuum at a certain distance and the force acting between them is F. If a medium of dielectric constant is 4 introduced around them, the force now will be:  
 (a)  $F/8$  (b)  $F/4$  (c)  $F$  (d)  $F/2$
24. The permittivity of a material medium compared with the permittivity of vacuum is called:  
 (a) Relative permittivity (b) Specific inductive capacity  
 (c) Dielectric constant (d) All of these
25. What is potential difference between two points in an electric field if it takes 600 J of energy to move a charge of 2 C between these two points?  
 (a) 300 V (b) 500 V (c) 400 V (d) 600 V

Sr.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
Ans:	a	c	b	b	d	c	b	d	b	d	c	b	c	a

26. Two capacitors of capacitance  $6\mu F$  and  $4\mu F$  are put in series across a 120 V battery. What is the potential difference across the  $4\mu F$  capacitor?  
 (a) 72 V (b) 60 V (c) 48 V (d) Zero
27. One of the plates X of a capacitor is connected to a source of +10 V. The other plate Y is earthed. What is the potential of the plate Y?  
 (a) -10 V (b) Zero (c) 10 V (d) 20 V
28. Two identical capacitors each with capacitance  $3\mu F$ , are connected in parallel and the combination is connected in series to a third identical capacitor. What is the charge stored in this combination if battery of 5 V is connected across it?  
 (a)  $10\mu C$  (b)  $12.5\mu C$  (c)  $5\mu C$  (d)  $7.5\mu C$
29. The ratio of  $C_{vac}$  to  $C_{med}$  is equal to:  
 (a)  $\epsilon_r$  (b)  $1/\epsilon_r$  (c)  $1/\epsilon_0$  (d)  $\epsilon_0$
30. A condenser having a capacity  $4.0\mu F$  is charged to 200 V and then plates of the capacitor are connected to a resistance wire. The heat produced will be:  
 (a)  $8 \times 10^4 J$  (b)  $4 \times 10^{10} J$  (c)  $8 \times 10^{-2} J$  (d)  $4 \times 10^{-2} J$
31. The energy stored in the capacitor is:  
 (a)  $(1/2) CV^2$  (b)  $(1/2) QV^2$  (c)  $(1/2) C^2V$  (d)  $(1/2) Q^2V$
32. The formula for discharging of a capacitor is:  
 (a)  $q = q_0(e^{-t/RC})$  (b)  $q = q_0(e^{-RC/t^2})$  (c)  $q = q_0(e^{-RC/t})$  (d)  $q = q_0(1 - e^{-RC/t})$
33. Coulomb force is a  
 (a) Short range force (b) Long range force  
 (c) Medium range force (d) None of these
34. Consider two capacitors with capacitance  $2\mu F$  capacitor have a greater amount of stored energy than the  $2\mu F$  capacitor?  
 (a) Series (b) Parallel (c) Either series nor parallel (d) Neither series nor parallel
35. Consider a capacitor has vacuum in the space between the conductors. If we double the amount of charge on each conductor, what happens to the capacitance?  
 (a) It increases (b) It decreases  
 (c) It remains same (d) It depends on the size or shape of the conductors
36. What is the SI unit of Potential difference?  
 (a) Volts (b) Coulomb (c) Meter (d) Newton's
37. Farad is defined as:  
 (a) Newton / volt (b) Coulomb / joule  
 (c) Coulomb / volt (d) Coulomb / newton
38. The value of K depends upon  
 (a) Charges (b) System of units and medium  
 (c) The distance between charges (d) Nature of medium
39. Static charge always creates  
 (a) Electric field and magnetic field (b) Electromagnetic wave  
 (c) Electric field (d) Both A and B
40. What is the energy stored in a capacitor of capacitance  $2\mu F$  and potential difference between the plates is 12V?  
 (a) 12 J (b) 24 J (c) 6 J (d)  $1/6 J$

Sr.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	a	b	a	b	c	a	a	b	b	c	a	c	b	c	b

41. If the potential difference across the two plates of a parallel capacitor is doubled, then energy stored in the capacitor would be:  
 (a) Remains same (b) Two times (c) Four times (d) Three times
42. One coulomb charge is carried by:  
 (a)  $6.25 \times 10^{18}$  electron (b) One electron (c) One proton (d)  $1.6 \times 10^{-19}$
43. The increase in the capacitance of a capacitor due to the presence of dielectric is due to:  
 (a) Electric polarization of dielectric (b) Density of dielectric  
 (c) Volume of dielectric (d) Magnetic dipole moment
44. Find the electric field strength required to hold suspended a particle of mass  $10^{-6}$  kg and charge  $1.0 \mu\text{C}$  between two plates 10.0 cm apart.  
 (a) 0.98 V/m (b) 980 V/m (c) 9.8 V/m (d) 98 V/m
45. The ratio of forces between two small spheres with constant charge (a) in air (b) in a medium of dielectric constant K is:  
 (a) 1:K (b) K:1 (c)  $1:K^2$  (d)  $K^2:1$
46. Electric field lines due to a negative charge are:  
 (a) Always horizontal (b) Always vertical  
 (c) Radially towards the charge (d) Radially away from the charge
47. You have three capacitors, each of  $3 \mu\text{C}$ . In which of the following combinations of the three capacitors, the resultant capacitance is  $9 \mu\text{C}$ ?  
 (a) All three capacitors in series  
 (b) Two capacitors are in series, one in parallel  
 (c) Two capacitors are in parallel, one in series  
 (d) All three capacitors in parallel
48. Coulomb per volt is called:  
 (a) Ampere (b) Electron volt (c) Joule (d) Farad
49. The unit of electric flux density is:  
 (a) N/C (b) V/m (c) Nm (d) A and B
50. A charge is moving with velocity  $v$ , if enters a uniform electric field  $\vec{E}$ . The direction of  $\vec{v}$  and  $\vec{E}$  are not parallel. What is the path of the charge particle inside the electric field?  
 (a) Parabolic (b) Circular (c) Parallel to  $v$  (d) Parallel to  $E$

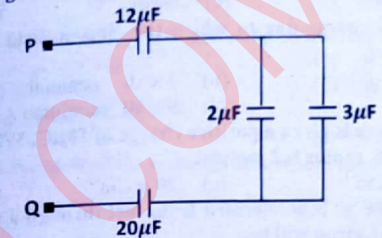
Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	a	a	c	b	c	d	d	d	a

1. Many computer keyboard buttons are constructed using capacitors. When a key is pushed down, the soft insulator between the moveable plate and the fixed plate is compressed. When the key is pressed what happens to the capacitance?  
 (a) It increases  
 (b) It decreases  
 (c) It remains same  
 (d) It changes in a way you cannot determine because of the complex circuit
2.  $C_{eq} = C_1 + C_2 + C_3 + \dots$  is the combination in  
 (a) Parallel (b) Series (c) Both of them (d) None of them
3. The distance between two point charges if halved, the force between them would be:  
 (a) Half (b) One fourth (c) Double (d) Four times
4. The unit of electric field strength is:  
 (a) V/C (b) N/V (c) N/C (d) N m
5. The force between two charges Q and q, separated by a distance d is F. What will be the force between them when distance between them is d/2?  
 (a) 4F (b) 2F (c) F (d) F/2
6. Electrostatic force is  
 (a) Nonconservative (b) Conservative  
 (c) Depends on shape of charge (d) None of these
7. Charged body attracts uncharged body by .... Induction  
 (a) Electrostatic (b) Magnetic (c) Both A and B (d) None of these
8. After how many time constants a capacitor is about completely discharged?  
 (a) 1 (b) 5 (c) 3 (d) 2
9. Which of the following is the same as farad?  
 (a)  $\Omega \text{ s}$  (b)  $\Omega^{-1} \text{ s}$  (c)  $\Omega \text{ s}^{-1}$  (d)  $\Omega^{-1} \text{ s}^{-1}$
10. When area of plates of capacitor is decreased, the capacitance will:  
 (a) Increase (b) Constant (c) Decrease (d) Become infinite
11. A capacitor of  $5 \mu\text{F}$  is connected with a battery of 12 V, the charge stored in capacitor:  
 (a)  $4 \times 10^{-5} \text{ C}$  (b)  $6 \times 10^{-5} \text{ C}$  (c)  $4 \times 10^{-6} \text{ C}$  (d)  $6 \times 10^{-6} \text{ C}$
12. The capacitor which charges and discharges quickly will have?  
 (a) Small value of RC (b) Large value of time constant  
 (c) Large value of RC (d) Zero value of time constant
13. The area of plates of 1 pico farad capacitor separated by 8.85 mm placed in the air is:  
 (a)  $1 \text{ mm}^2$  (b)  $10 \text{ mm}^2$  (c)  $100 \text{ mm}^2$  (d)  $1000 \text{ mm}^2$
14. A battery is permanently connected to a parallel plate capacitor and the energy stored is x joules. When one plate is moved so that separation of the plate is doubled, the energy now stored in joule is:  
 (a) 4x (b) x/2 (c) 2x (d) x/4
15. Two capacitors of capacitance  $0.3 \mu\text{F}$  and  $0.6 \mu\text{F}$  respectively are connected in series. The combination is connected across a potential of 6 V. The ratio of energy stored by capacitors is:  
 (a)  $\frac{1}{2}$  (b) 2 (c)  $\frac{1}{4}$  (d) 4
16. Capacitor stores energy in the form of:  
 (a) Electric field (b) Magnetic field  
 (c) Electromagnetic field (d) Gravitational field

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Ans:	a	a	d	c	a	b	a	b	b	c	b	a	a	b	b	a

17. The electric potential at a point of distance 1 m from 2  $\mu\text{C}$  charge is:  
 (a)  $1.8 \times 10^6 \text{ V}$  (b)  $1.8 \times 10^4 \text{ V}$  (c)  $1.8 \times 10^8 \text{ V}$  (d)  $1.8 \times 10^5 \text{ V}$
18. Charge is distributed uniformly on the surface of large flat plate. The electric field 2 cm from the plate is  $20 \text{ N C}^{-1}$ . What is the electric field at 4 cm from the plate?  
 (a)  $120 \text{ N C}^{-1}$  (b)  $15 \text{ N C}^{-1}$  (c)  $20 \text{ N C}^{-1}$  (d)  $7.5 \text{ N C}^{-1}$
19. For an isolated positive charge, the zero-field spot lies:  
 (a) At 2 m from charge (b) At infinity  
 (c) At 10 m from charge (d) At very small distance from charge
20. By moving charge of 20 C by 2 cm, 2 J of work is done. The potential difference between the points:  
 (a) 0.1 V (b) 8 V (c) 2 V (d) 0.5 V
21. Which of the following is correct?  
 (a) Joule = coulomb / volt (b) Joule = volt / ampere  
 (c) Joule = volt x ampere (d) Joule = coulomb x volt
22. The vector form of electric field intensity due to a negative charge is:  
 (a)  $\vec{E} = -\frac{kq q_0}{r^2} \hat{r}$  (b)  $\vec{E} = \frac{kq q_0}{r^2} \hat{r}$  (c)  $\vec{E} = -\frac{kq}{r^2} \hat{r}$  (d)  $\vec{E} = -\frac{kq}{r} \hat{r}$
23. The minimum charge on an object is:  
 (a) 1 C (b)  $6.25 \times 10^{18} \text{ C}$  (c)  $1.6 \times 10^{-10} \text{ C}$  (d)  $1.6 \times 10^{-19} \text{ C}$
24. The magnitude of  $\frac{1}{4\pi\epsilon_0}$  is:  
 (a)  $9 \times 10^9$  (b)  $9 \times 10^{-9}$  (c)  $8.85 \times 10^{-12}$  (d)  $8.85 \times 10^{12}$
25. Three capacitors each of  $6\mu\text{F}$  are available. The minimum and maximum capacitors which may be obtained are:  
 (a)  $6\mu\text{F}$ ,  $18\mu\text{F}$  (b)  $3\mu\text{F}$ ,  $12\mu\text{F}$  (c)  $2\mu\text{F}$ ,  $12\mu\text{F}$  (d)  $2\mu\text{F}$ ,  $18\mu\text{F}$
26. Two capacitors connected in parallel having the capacities  $C_1$  and  $C_2$  are given 'q' charge, which is distributed among them. The ratio of charges is:  
 (a)  $\frac{C_1}{C_2}$  (b)  $\frac{1}{C_1 C_2}$  (c)  $\frac{C_2}{C_1}$  (d)  $C_1 C_2$
27. If there are n capacitors in parallel connected to V volt source, then the energy stored is equal to:  
 (a) CV (b)  $CV^2$  (c)  $\frac{1}{2}nCV^2$  (d)  $\frac{1}{2n}CV^2$
28. A capacitor of capacity  $50\mu\text{F}$  is charged to 10 V, its energy is equal to:  
 (a)  $2.5 \times 10^{-3} \text{ J}$  (b)  $2.5 \times 10^{-4} \text{ J}$  (c)  $5 \times 10^{-2} \text{ J}$  (d)  $1.2 \times 10^{-8} \text{ J}$
29. A drop of  $10^{-6} \text{ kg}$  water carries  $10^{-6} \text{ C}$  charge. What electric field should be applied to balance its weight  
 (a)  $10 \text{ Vm}^{-1}$  upward (b)  $10 \text{ Vm}^{-1}$  downward  
 (c)  $0.1 \text{ Vm}^{-1}$  upward (d)  $0.1 \text{ Vm}^{-1}$  downward
30. The force between the plates of parallel plates capacitor of capacitance C and distance of separation of plates D with a potential difference V between the plates is,  
 (a)  $\frac{CV^2}{2d}$  (b)  $\frac{C^2 V^2}{2d^2}$  (c)  $\frac{C^2 V^2}{d^2}$  (d)  $\frac{V^2 d}{C}$
31. An electron is moving towards x-axis. An electric field is along y-direction then path of electron is:  
 (a) Circular (b) Elliptical (c) Parabola (d) None of these
32. A proton is accelerated through 50,000 V. Its energy will increase by:  
 (a) 5000 eV (b)  $8 \times 10^{15} \text{ J}$  (c) 5000 J (d) 50,000 J

Sr.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.
Ans:	b	c	b	a	d	c	d	a	d	a	c	a	a	b	c	b

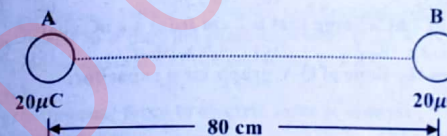
33. Two plates are 2 cm apart, a potential difference of 10 V is applied between them, the electric field between the plates is:  
 (a)  $20 \text{ NC}^{-1}$  (b)  $500 \text{ NC}^{-1}$  (c)  $5 \text{ NC}^{-1}$  (d)  $250 \text{ NC}^{-1}$
34. An electron is moving around the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force  $\vec{F}$  between the two is:  
 (a)  $-K\frac{e^2}{r^3} \hat{r}$  (b)  $K\frac{e^2}{r^3} \hat{r}$  (c)  $-K\frac{e^2}{r^3} \hat{r}$  (d)  $-K\frac{e^2}{r^2} \hat{r}$
35. In the circuit diagram shown in the adjoining figure, the resultant capacitance between P and Q is:  
  
 (a)  $47 \mu\text{F}$  (b)  $3 \mu\text{F}$  (c)  $60 \mu\text{F}$  (d)  $10 \mu\text{F}$
36. The capacity of a condenser is  $4 \times 10^{-6}$  farad and its potential is 100 volts. The energy released on discharging it fully will be:  
 (a) 0.02 J (b) 0.04 J (c) 0.025 J (d) 0.05 J
37. An electron enters in an electric field with its velocity in the direction of the electric lines of force. Then,  
 (a) Path of electron will be a circle (b) Path of electron will be a parabola  
 (c) Velocity of electron will decrease (d) Velocity of electron will increase
38. Two unlike charges of magnitude q are separated by a distance 2d. The potential at a point midway between them is:  
 (a) Zero (b)  $\frac{1}{4\pi\epsilon_0}$  (c)  $\frac{1}{4\pi\epsilon_0} \frac{q}{d}$  (d)  $\frac{1}{4\pi\epsilon_0} \frac{2q}{d^2}$
39. Two charge +q and -q are situated at a certain distance. At the point exactly midway between them:  
 (a) Electric field and potential both are zero (b) Electric field is zero but potential is not zero  
 (c) Electric field is not zero but potential is zero (d) Neither electric field nor potential is zero
40. Two charged sphere of radii 10 cm and 15 cm are connected by a thin wire. No current will flow, if they have:  
 (a) Same charge on each (b) Same potential  
 (c) Same energy (d) Same field on their surfaces
41. Two electrons are separated by a distance of  $1\text{\AA}$ . What is the coulomb force between them:  
 (a)  $2.3 \times 10^{-8} \text{ N}$  (b)  $4.6 \times 10^{-8} \text{ N}$  (c)  $1.5 \times 10^{-8} \text{ N}$  (d) None of these
42. Two charges each of 1 coulomb are at a distance 1 km apart, the force between them is:  
 (a)  $9 \times 10^3 \text{ Newton}$  (b)  $9 \times 10^{-3} \text{ Newton}$  (c)  $1.1 \times 10^{-4} \text{ Newton}$  (d)  $10^4 \text{ Newton}$
43. There are two charges +1 micro coulombs and +5 micro coulombs. The ratio of the forces acting on them will be:  
 (a) 1:5 (b) 1:1 (c) 5:1 (d) 1:25

Sr.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	b	d	b	a	c	a	c	b	a	b	b

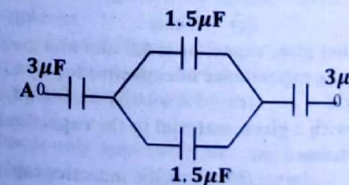
44. When  $10^{14}$  electrons are removed from the neutral metal sphere, the charge on the sphere becomes:  
 (a)  $16 \mu\text{C}$  (b)  $-16 \mu\text{C}$  (c)  $32 \mu\text{C}$  (d)  $-32 \mu\text{C}$
45. The electric charge in uniform motion produces:  
 (a) An electric field only (b) A magnetic field only  
 (c) Both electric and magnetic field (d) None
46. An electron and a proton are placed in a uniform electric field, the ratio of their accelerations will be:  
 (a) Zero (b) Unity (c)  $m_p/m_e$  (d)  $m_e/m_p$
47. What is the magnitude of a point charge due to which the electric field 30 cm away has the magnitude 2 Newton/coulomb.  
 (a)  $2 \times 10^{-11}$  coulomb (b)  $3 \times 10^{-11}$  coulomb  
 (c)  $5 \times 10^{-11}$  coulomb (d)  $9 \times 10^{-11}$  coulomb
48. A hollow insulated conducting sphere is given a positive charge of  $10 \mu\text{C}$ . What will be the electric field at the centre of the sphere if its radius is 2 meters:  
 (a) Zero (b)  $\mu\text{Cm}^{-2}$  (c)  $20 \mu\text{Cm}^{-2}$  (d)  $8 \mu\text{Cm}^{-2}$
49. An electron of mass 'm' and charge 'e' is accelerated from rest through a potential difference V in vacuum. The final speed of the electron will be:  
 (a)  $V\sqrt{e/m}$  (b)  $\sqrt{eV/m}$  (c)  $\sqrt{2eV/m}$  (d)  $2eV/m$
50. The energy of a charged capacitor is given by the expression:  
 (a)  $\frac{q^2}{2C}$  (b)  $\frac{q^2}{C}$  (c)  $2qC$  (d)  $\frac{q}{2C^2}$

Sr.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	c	c	a	a	c	a

1. One plate of parallel plate capacitor is smaller than other, then charge on smaller will be:  
 (a) Less than other (b) More than other  
 (c) Equal to other (d) Will depend upon medium between them
2. Charge on  $\alpha$  - particle is:  
 (a)  $4.8 \times 10^{-19} \text{C}$  (b)  $3.2 \times 10^{-19} \text{C}$  (c)  $1.6 \times 10^{-19} \text{C}$  (d)  $6.4 \times 10^{-19} \text{C}$
3. If a unit positive charge is taken from one point to another over an equipotential surface, the:  
 (a) Work is done on the charge (b) Work is done by the charge  
 (c) Work done is constant (d) Work done is zero
4. The unit of intensity of electric field is:  
 (a)  $\text{NC}^{-1}$  (b)  $\text{JC}^{-1}$  (c)  $\text{Vm}$  (d)  $\text{Nm}^{-1}$
5. In the given figure distance of the point from A where the electric field is zero is:



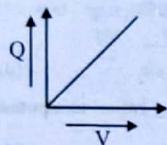
- (a) 20 cm (b) 10 cm (c) 33 cm (d) 40 cm
6. The energy stored in condenser of capacity C which has been raised to a potential V is given by:  
 (a)  $\frac{1}{2}CV$  (b)  $\frac{1}{2}CV^2$  (c) CV (d)  $\frac{1}{2CV}$
7. A parallel plate capacitor is first charged then a dielectric slab is introduced between the plates. The quantity that remains unchanged:  
 (a) Charge (b) Potential (c) Capacitance (d) Energy
8. If a dielectric substance is introduced between the plates of a charged air-gap capacitor. The energy of capacitor will:  
 (a) Increase (b) Decrease  
 (c) Remain unchanged (d) First increase then decrease
9. Two capacitors each of capacity  $2 \mu\text{F}$  are connected in parallel. This system is connected in series with a third capacitor of  $12 \mu\text{F}$  capacity. The equivalent capacity of the system will be:  
 (a)  $16 \mu\text{F}$  (b)  $13 \mu\text{F}$  (c)  $4 \mu\text{F}$  (d)  $3 \mu\text{F}$
10. The capacitance between points A and B in the given circuit will be:



- (a)  $1 \mu\text{F}$  (b)  $2 \mu\text{F}$  (c)  $3 \mu\text{F}$  (d)  $4 \mu\text{F}$

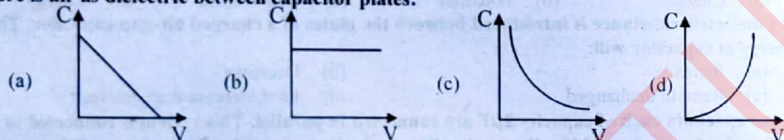
Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Ans:	c	b	d	a	d	b	a	b	d	a

11. Electric lines of force around a negative point charge are:  
 (a) Circular, anticlockwise (b) Radial, inwards  
 (c) Circular, clockwise (d) Radial, outwards
12. Electric field at a distance of 10 cm from an isolated point particle with a charge of  $2 \times 10^{-9}$  C is:  
 (a)  $1.8 \text{ N C}^{-1}$  (b)  $18 \text{ N C}^{-1}$  (c)  $180 \text{ N C}^{-1}$  (d)  $1800 \text{ N C}^{-1}$
13. Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge:  
 (a) Electric current (b) Electric power  
 (c) Electric field strength (d) Electric energy
14. Two charges are placed at a certain distance apart in vacuum. If a glass slab is placed between them. The force between them:  
 (a) Will increase (b) Will remain unchanged  
 (c) Will decrease (d) Will become infinity
15. When  $10^{12}$  electrons are received from a neutral metal sphere. The charge on the sphere becomes:  
 (a)  $0.16 \mu\text{C}$  (b)  $0.32 \mu\text{C}$  (c)  $-0.1 \mu\text{C}$  (d)  $-0.32 \mu\text{C}$
16. What is electric potential energy of 7 nC charge that is 2 cm from a 2 nC charge:  
 (a)  $6.3 \times 10^{-6} \text{ J}$  (b)  $2.3 \times 10^{-6} \text{ J}$  (c)  $4.3 \times 10^{-6} \text{ J}$  (d)  $6.3 \times 10^{-7} \text{ J}$
17. Which of the following provides us the slope of Q-V graph for a capacitor:



- (a) Capacitance (b) Energy (c) Energy density (d) Pressure

18. In the relation  $Q=CV$ , which graph correctly describes the relation between "C" and "V" when there is air as dielectric between capacitor plates:



19. If mica sheet is placed between the plates of capacitor, the capacity will:  
 (a) Increase (b) Remain same (c) Decrease (d) Become zero
20. Ohm x farad is equivalent to:  
 (a) Second (b) Henry (c) Weber (d) Tesla
21. The distance between the plates of a parallel plate capacitor is 4.0 mm and area of each plate is  $8\text{m}^2$ . The plates are in a vacuum. What is the capacitance of capacitor?  
 (a)  $1.7 \times 10^{-8} \text{ F}$  (b)  $8.85 \times 10^{-9} \text{ F}$  (c)  $3.4 \times 10^{-9} \text{ F}$  (d)  $9.0 \times 10^{-9} \text{ F}$
22. The ratio of the capacitance of capacitor with a given material to the capacitance of the same capacitor when the medium is vacuum is termed as:  
 (a) Permittivity of free space (b) Specific inductive capacity  
 (c) Dielectric constant (d) Energy stored

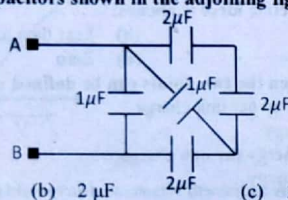
Sr.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	b	d	d	c	a	a	a	c	a	a	a	c

23. Capacity of a capacitor depend upon?

- (a) Size of plates (b) Nature of dielectric between the plates  
 (c) Distance between the plates (d) All of these
24. The ratio of instantaneous charge and maximum charge on plates of capacitor at  $t=RC$  is (during discharging of capacitor):  
 (a) 37 % (b) 99.3 % (c) 63 % (d) 3.25 %
25. Formula for electric field intensity is  
 (a)  $E=F/q$  (b)  $E=3F/2q$  (c)  $E=F/3q$  (d) None of them
26. The electron volt is the unit of  
 (a) Electric current (b) Electric potential (c) Electric energy (d) Electric flux
27. A capacitor stores charge  $Q$  at a potential difference  $\Delta V$ . What happens if the voltage applied to the capacitor by a battery is doubled to  $2\Delta V$ ?  
 (a) The capacitance falls to half its initial value, and the charge remains the same  
 (b) The capacitance and the charge both fall to half their initial values  
 (c) The capacitance and the charge both double  
 (d) The capacitance remains the same, and the charge doubles
28. The energy stored in a parallel plate capacitor is 24 J. What is the potential difference between the plates if the capacitance of the capacitor is  $3 \mu\text{F}$ ?  
 (a) 4 KV (b) 54 KV (c) 16 KV (d) 8 KV
29. The ratio gravitational force to electric force is always:  
 (a) Greater than unity (b) Less than unity  
 (c) Equal to unity (d) Zero
30. Electric potential difference between the two points can be defined as:....  
 (a) Difference of the kinetic energy per unit charge  
 (b) Difference of the kinetic energy  
 (c) Difference of the potential energy per unit charge  
 (d) Difference of the potential energy
31. The SI unit of electric intensity is:  
 (a) Volt / meter (b) Newton / meter (c) Tesla (d) Coulomb / meter
32. The SI Unit of electric charge is:  
 (a) Coulomb (b) Ampere (c) Hertz (d) Volt
33.  $E=F/q$  is the formula for?  
 (a) Electrical field strength (b) Electrical field intensity  
 (c) Both of them (d) None of them
34. The charge on electron is equal to  
 (a) Proton (b) Two protons (c) Two neutrons (d) None of these
35. The capacitance of a capacitor is a measure of its ability to:  
 (a) Store charge (b) Store electric field  
 (c) Gain potential difference (d) Store magnetic field
36. Electric field at a point varies as  $r^0$  for:  
 (a) A plane infinite sheet of charge (b) A point charge  
 (c) Electric dipole (d) Line charge of infinite length
37. Coulomb's law is only applicable for:  
 (a) Big charges (b) Small charges (c) Point charges (d) Any charges
38. Electric intensity at the centre of uniformly distributed charged sphere is:  
 (a) Zero (b)  $Kq/r^2$  (c)  $q/r^2$  (d)  $q/\epsilon_0$
39. The value for  $\epsilon_r$  for air is:  
 (a) 1.6 (b) 1.06 (c) 1.006 (d) 1.0006

Sr.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.
Ans:	d	a	a	c	d	a	b	c	a	a	c	a	b	a	c	a	d

40. Force acting on a positive charge is always:  
 (a) In the direction opposite to electric field  
 (b) In the direction of electric field  
 (c) In the direction of perpendicular to electric field  
 (d) In the direction perpendicular to the velocity of charges
41. A particle carrying a charge  $3e$ , accelerates through a potential difference of 2V. The energy acquired by it is:  
 (a) 6eV (b) 1.5eV (c) 0.66eV (d) 12eV
42. Electric potential difference can be defined as:  
 (a)  $\Delta V = \Delta U - q$  (b)  $\Delta V = \Delta U / q$  (c)  $\Delta V = \Delta U + q$  (d)  $\Delta V = \Delta U \cdot q$
43. A proton has mass  $m$  and charge  $q$ . It is suspended in electric and gravitational field. What is the magnitude of electric field?  
 (a)  $E = mg / q$  (b)  $E = mg / qv$  (c)  $E = mg / qvB$  (d)  $E = q / mg$
44. A charge of 2 C placed in electric field of 10 N/C what will be the work done in moving charge a distance of 5 m:  
 (a) 100 J (b) 50 J (c) 150 J (d) 200 J
45. Two charges of equal magnitude and at a distance  $r$  exerts a force  $F$  on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is:  
 (a)  $F/8$  (b)  $F/4$  (c)  $4F$  (d)  $F/16$
46. The total capacity of capacitors shown in the adjoining figure between the points A and B is:



- (a) 1  $\mu F$  (b) 2  $\mu F$  (c) 3  $\mu F$  (d) 4  $\mu F$
47. The distance between the plates of a parallel plate capacitor is 2.0 mm and area of each plate is 2.0 m<sup>2</sup>. The plates are in a vacuum. A potential difference of  $1.0 \times 10^4$  V is applied across the plates. Find the capacitance.  
 (a)  $4 \times 10^{-3}$  F (b)  $3.54 \times 10^{-9}$  F (c)  $8.85 \times 10^{-9}$  F (d)  $9.0 \times 10^{-9}$  F
48. If the length, width and separation between the plates of a parallel plate capacitor is doubled then its capacitance becomes:  
 (a) Double (b) Half (c) Four-times (d) Eight-times
49. The formula for electric field strength is ' $E = F/Q$ ', where  $E$  is electric field strength and  $F$  is force and  $Q$  is charge. Which one of the following options gives the correct base units for electric field strength?  
 (a)  $\text{kgms}^{-2}\text{A}^{-1}$  (b)  $\text{kg s}^{-2}\text{A}^{-1}$  (c)  $\text{kg}^2\text{m}^{-2}\text{s}^{-3}\text{A}$  (d)  $\text{ms}^{-1}\text{A}^{-3}$
50. For a heat engine 'A' ratio of  $Q_2$  to  $Q_1$  is  $2/3$  while that of heat engine 'B', ratio of  $Q_2$  to  $Q_1$  is  $1/3$ . What is the value  $\eta_A : \eta_B$ ?  
 (a) 1:3 (b) 2:3 (c) 1:2 (d) 2:1

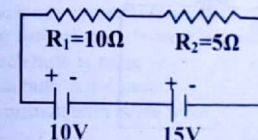
Sr.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	a	b	a	a	d	b	c	a	a	c

## UNIT 07 &gt;&gt;

## CURRENT ELECTRICITY

## PRACTICE TEST NO. 1

1. Two unequal resistances are connected in parallel across a battery. Which of the following statement is true?  
 (a) Same current will flow through both resistance  
 (b) Current through smaller resistance is higher  
 (c) Current through larger resistance is higher  
 (d) Current can be higher in any resistance depending on emf of the cell
2. Three resistors of 2, 3 and 5  $\Omega$  are connected in the form of a triangle. If a battery of 2.5 V is connected across 5  $\Omega$  resistor, then the current passing through 3  $\Omega$  will be:  
 (a) 1A (b) 0.25 A (c) 0.5 A (d) 0.75 A
3. A 50 V battery is connected across a 10 ohm resistor. The current is 4.5 amperes. The internal resistance of the battery is:  
 (a) Zero (b) 0.5 ohm (c) 1.1 ohm (d) 5 ohm
4. In the diagram shown, the current through the resistor will be:



- (a)  $\frac{5}{3}$  A clockwise (b)  $\frac{5}{2}$  A clockwise (c)  $\frac{1}{3}$  A anticlockwise (d)  $\frac{5}{3}$  A anticlockwise
5. Two wires of same material have length  $L$  and  $2L$  and cross-sectional areas  $4A$  and  $A$  respectively. The ratio of their specific resistance would be:  
 (a) 1:2 (b) 8:1 (c) 1:8 (d) 1:1
6. An electric bulb of 100 watt is connected to a supply of electricity of 220V. Resistance of the filament is:  
 (a) 484  $\Omega$  (b) 100  $\Omega$  (c) 22000  $\Omega$  (d) 242  $\Omega$
7.  $62.5 \times 10^{18}$  electrons per second are flowing through a wire of area of cross-section  $0.1 \text{ m}^2$ , the value of current flowing will be:  
 (a) 1A (b) 0.1 A (c) 10 A (d) 0.11 A
8. You are given three bulbs of 25, 40 and 60 watt. Which of them has lowest resistance:  
 (a) 25 watt bulb (b) 40 watt bulb (c) 60 watt bulb (d) Insufficient info
9. The resistance of a conductor is 5 ohm at  $50^\circ\text{C}$  and 6 Ohm at  $100^\circ\text{C}$ , the resistance at  $0^\circ\text{C}$  is:  
 (a) 1ohm (b) 2 ohm (c) 4 ohm (d) 3 ohm
10. A current of 1 mA is flowing through a copper wire. How many electrons will pass a given point in 1 s:  
 (a)  $6.25 \times 10^{19}$  (b)  $6.25 \times 10^{15}$  (c)  $6.25 \times 10^{31}$  (d)  $6.25 \times 10^8$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Ans:	b	a	c	a	d	a	c	c	c	b

11. The example for non-ohmic resistance is:

- (a) Copper wire (b) Filament bulb (c) Diode (d) Both b and c

12. An expression for rate of heat generated, if a current of  $I$  ampere flow through the bulb is:

- (a)  $I^2 R t$  (b)  $I^2 R$  (c)  $V^2 R$  (d)  $IR$

13.  $\sigma_1$  and  $\sigma_2$  are electrical conductivities of Ge and Na respectively. If these substances are heated then,

- (a) Both  $\sigma_1$  and  $\sigma_2$  increase (b)  $\sigma_1$  increases and  $\sigma_2$  decreases  
(c)  $\sigma_1$  decreases and  $\sigma_2$  increases (d) Both  $\sigma_1$  and  $\sigma_2$  decreases

14. Five cells, each of emf  $E$  and internal resistance ' $r$ ', are connected in series. If by mistake one the cells is connected wrongly, the equivalent emf and internal resistance of the combination are?

- (a)  $5E, 5r$  (b)  $3E, 3r$  (c)  $5E, 3r$  (d)  $3E, 5r$

15. Four identical cells each having an emf of 12V, are connected in parallel. The electromotive force of the combination is:

- (a) 48 V (b) 12V (c) 4V (d) 3V

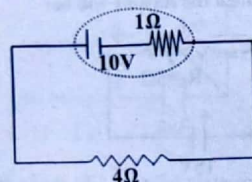
16. A student has 10 resistors of resistance ' $r$ '. The minimum resistance made by him from given resistors is:

- (a)  $10r$  (b)  $\frac{r}{10}$  (c)  $\frac{r}{100}$  (d)  $\frac{r}{5}$

17.  $20\mu A$  current flows for 30 s in a wire, transfer of charge will be:

- (a)  $2 \times 10^{-4} C$  (b)  $4 \times 10^{-4} C$  (c)  $6 \times 10^{-4} C$  (d)  $8 \times 10^{-4} C$

18. In the circuit shown, the rate of energy dissipation in the battery is:

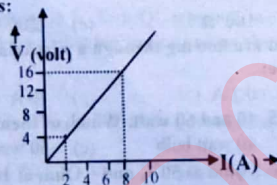


- (a) 2W (b) 6W (c) 4W (d) 16W

19. The resistance of hot tungsten filament is about 10 times more than the resistance of cold tungsten filament. What will be the resistance of 100 W and 200 V lamp when hot in use?

- (a)  $40\Omega$  (b)  $400\Omega$  (c)  $200\Omega$  (d)  $20\Omega$

20. Variation of current and voltage in a conductor has been shown in the diagram below, The resistance of the conductor is:



- (a) 4 ohm (b) 2 ohm (c) 3 ohm (d) 1 ohm

21. The current in a resistor is 12.0 mA. What charge flows through the resistor in 0.020 s?

- (a) 0.16 mC (b) 2.4 mC (c) 0.24 mC (d) 0.40 mC

22. A copper coil has resistance  $200\Omega$  at  $0^\circ C$ . Its resistance at  $80^\circ C$  is ( $\alpha = 0.004041^\circ C^{-1}$ ):

- (a)  $264.65\Omega$  (b)  $325.45\Omega$  (c)  $264.65\Omega$  (d)  $325.45\Omega$

Sr.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	d	b	b	d	b	b	c	c	a	b	c	a

23. A steady current flow in metallic conductor of non-uniform cross-section. The quantity / quantities constant along the length of the conductor is / are:

- (a) Drift velocity only (b) Current and drift speed  
(c) Current, drift velocity and drift speed (d) Current only

24. The resistivity of iron is  $1 \times 10^{-7}\Omega$ . The resistance of an iron wire of particular length and thickness is  $1\Omega$ . If both the length and the diameter of wire are doubled, then the resistivity in  $m$  will be:

- (a)  $1 \times 10^{-7}$  (b)  $2 \times 10^{-7}$  (c)  $4 \times 10^{-7}$  (d)  $8 \times 10^{-7}$

25. A potential difference  $V$  is applied to a conductor of length  $\ell$  and radius  $r$ . When potential difference is doubled, the drift velocity is:

- (a) Halved (b) Unchanged (c) Doubled (d) Quadrupled

26. Read the following statements:

Y: The resistivity of a semiconductor decrease with increase of temperature

Z: In a conducting solid, the rate of collisions between free electrons and ions increase with increase of temperature.

Select the correct statement(s) from the following:

- (a) Y is true but Z is false  
(b) Both Y and Z are true  
(c) Y is false but Z is true  
(d) Y is true and Z is the correct reason for Y.

27. Terminal potential difference and electromotive force:

- (a) Have same units (b) Always have same values  
(c) Have different units (d) Always have different values

28. The four bulbs of 60 W each are connected in series and a battery is connected across their combination. Which of the following statement is true?

- (a) Current through each bulb is same  
(b) Voltage across each bulb is not same  
(c) Power dissipation in each bulb is not same  
(d) All of these

29. A unit of electricity is usually equal to:

- (a) One kilowatt (b) One watt minute  
(c) One kilowatt hour (d) One joule hour

30. A battery of four cells in series, each having an emf of 1.4 V and an internal resistance of  $2\Omega$ , is to be used to charge a small 2 V accumulator of negligible internal resistance. The charging current is:

- (a) 0.1 A (b) 0.2 A (c) 0.3 A (d) 0.45 A

31. You have three appliances, each of 500 W, running on 220 V a.c: (i) an electric lamp, (ii) an electric iron (iii) an electric room heater. The electrical resistance is:

- (a) Maximum for electric lamp (b) Maximum for electric iron  
(c) Maximum for the heater (d) Same for all

32. In the short circuit, current is \_\_\_\_\_ and in the open circuit, resistance is \_\_\_\_\_:

- (a) Zero, infinite (b) Zero, zero (c) Infinite, infinite (d) Infinite, zero

33. Which statement describes the electrical potential difference between two points in a wire carrying a current?

- (a) The force required to move a unit positive charge between the points  
(b) The ratio of the energy dissipated between the points to the current  
(c) The ratio of the power dissipated between the points to the current  
(d) The ratio of the power dissipated between the points to the charge moved

Sr.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
Ans:	d	a	c	b	a	a	c	d	d	c	c

34. A cell of internal resistance  $2.0\Omega$  and electromotive force (e.m.f)  $1.5\text{ V}$  is connected to a resistor of resistance  $3.0\Omega$ . What is the potential difference across internal resistor?  
(a) 5 (b) 0.9 (c) 1.2 (d) 0.6
35. Which of the following units are equivalent?  
(a) (A) and (C s) (b) (A  $\Omega$ ) and (J C) (c) (A<sup>2</sup>  $\Omega$ ) and (CV s<sup>-1</sup>) (d) (A V) and (W s)
36. The potential difference between the terminals of a cell in open circuit is  $2.2\text{ volt}$ . With resistance of  $5\text{ ohm}$  across the terminals of a cell, the terminal potential difference is  $1.8\text{ volt}$ . The internal resistance of the cell is:  
(a)  $\frac{9}{10}\text{ ohm}$  (b)  $\frac{10}{9}\text{ ohm}$  (c)  $\frac{7}{12}\text{ ohm}$  (d)  $\frac{12}{7}\text{ ohm}$
37. The resistor of resistance  $R$  is connected to  $25\text{ V}$  supply, rate of heat produced in it is  $25\text{ J s}^{-1}$ . The value of  $R$  is:  
(a)  $225\Omega$  (b)  $50\Omega$  (c)  $25\Omega$  (d)  $125\Omega$
38. A heating coil has a resistance of  $20\Omega$ . It is designed to operate on  $220\text{ V}$ . What electric energy in joules is supplied to heater in  $10\text{ s}$ ?  
(a)  $2420\text{ J}$  (b)  $242000\text{ J}$  (c)  $24.2\text{ kJ}$  (d)  $2.4\text{ MJ}$
39. Ohm's Law is applicable only when temperature remains:  
(a) Changing (b) Absolute zero (c) Constant (d) None of these
40. Electric power is  
(a) Rate of electric work done per unit time (b) Voltage per unit time  
(c) Electric charge per unit time (d) Current per unit time
41. When bulb is turned on, ohm's law is applicable  
(a) Yes (b) No (c) Partly (d) None of these
42. The temperature coefficient of resistance is expressed in:  
(a)  $^{\circ}\text{C}$  (b)  $^{\circ}\text{C}^{-1}$  (c)  $\text{m}^{\circ}\text{C}^{-1}$  (d) None of these
43.  $4000\text{ Coulomb}$  charges were passing from the wire for about  $12\text{ seconds}$ . Estimate the current during this process?  
(a)  $333.3\text{ ampere}$  (b)  $666.67\text{ ampere}$  (c)  $333.33\text{ volts}$  (d) None of these
44. Internal resistance is the resistance offered by  
(a) Source of emf (b) Conductor (c) Resistor (d) Capacitor
45. Electric current may be defined as  
(a) Rate of flow of charge (b) Rate of flow of momentum  
(c) Rate of flow of power (d) None of them
46. A current of  $16\text{ amperes}$  divides between two branches in parallel of resistance  $8\text{ ohms}$  and  $12\text{ ohms}$  respectively. The current in each branch is:  
(a)  $6.4\text{ A}$ ,  $6.9\text{ A}$  (b)  $6.4\text{ A}$ ,  $9.6\text{ A}$  (c)  $4.6\text{ A}$ ,  $6.9\text{ A}$  (d)  $4.6\text{ A}$ ,  $9.6\text{ A}$
47. If a current of  $5\text{ amperes}$  flows through the conductor. The number of electrons per second will be:  
(a)  $1.0 \times 10^{19}$  (b)  $3.12 \times 10^{19}$  (c)  $4 \times 10^{19}$  (d)  $7.68 \times 10^{20}$
48. What is the power of a bulb if it is operated at  $220\text{ V}$  and the current in the circuit is  $1.5\text{ Amp}$ .  
(a)  $330\text{ watt}$  (b)  $430\text{ watt}$  (c)  $530\text{ watt}$  (d)  $500\text{ watt}$
49. Maximum power is delivered when internal resistance of the source equals:  
(a) Zero resistance (b) Load resistance (c) Max resistance (d) None of these
50.  $1\text{ kilo ohm} = \text{_____ ohm}$   
(a)  $10^3\text{ ohm}$  (b)  $10^2\text{ ohm}$  (c)  $10^4\text{ ohm}$  (d) None of these

Sr.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	b	b	c	c	c	a	b	b	a	a	a	b	b	a	b	a

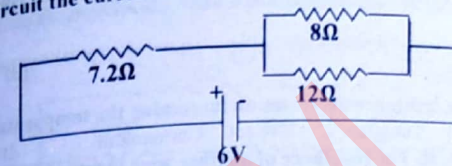
1. A wire has a resistance of  $5.5\Omega$  at  $19^{\circ}\text{C}$  and  $21.5\Omega$  at  $200^{\circ}\text{C}$ . Find the temperature coefficient of resistivity ( $\alpha$ ) of the material.  
(a)  $0.016\text{ per degree Celsius}$  (b)  $32\text{ per degree Celsius}$   
(c)  $0.018\text{ per degree Celsius}$  (d)  $0.00106\text{ per degree Celsius}$
2. Four  $100\text{ W}$  bulbs are connected in parallel across  $200\text{ V}$  supply line. If one bulb gets fused  
(a) No bulb will light (b) All the four bulbs will light  
(c) Rest of three bulbs will light (d) Both b and c
3. SI unit of voltage is  
(a) Coulomb (b) Volts (c) Ampere (d) Newton's Meter
4. How much potential difference is required for establishing steady current?  
(a) Minimum (b) Maximum (c) Constant (d) Varying
5. Which one of the following bulbs has the least resistance?  
(a)  $100\text{ W}$  (b)  $300\text{ W}$   
(c)  $200\text{ W}$  (d)  $60\text{ W}$
6. The length and radius of a certain wire are doubled simultaneously, then the resistance will:  
(a) Resistance will be doubled and specific resistance will be halved  
(b) Resistance will be halved and specific resistance will remain unchanged  
(c) Resistance will be halved and the specific resistance will be doubled  
(d) Resistance and specific resistance will both remain unchanged
7. Why should a resistance be introduced in a circuit in series deliberately?  
(a) To increase current (b) To decrease current  
(c) To control current (d) Just to give a good look to the current
8. Steady current does not change with respect to .....  
(a) Conductor (b) Source (c) Time (d) Potential difference
9. Six lamps of  $40\text{ watts}$  each working for  $4\text{ hours}$  per day will consume \_\_\_\_\_ energy in a month:  
(a)  $28.8\text{ kWh}$  (b)  $22.8\text{ kWh}$  (c)  $38.8\text{ kWh}$  (d)  $33.8\text{ kWh}$
10. A soldering iron draw  $7.5\text{ A}$  in a  $115\text{ V}$  circuit. What is its wattage rating?  
(a)  $563$  (b)  $763$  (c)  $663$  (d)  $863$
11. The terminal potential difference of a cell when open circuited is (where "E" is emf of cell):  
(a) E (b) Zero (c)  $\frac{E}{2}$  (d)  $\frac{E}{3}$
12. When three identical bulbs of  $60\text{ W}$ ,  $200\text{ V}$  rating are connected in series to a  $200\text{ V}$  supply, the power drawn by them will be:  
(a)  $60\text{ W}$  (b)  $10\text{ W}$  (c)  $180\text{ W}$  (d)  $20\text{ W}$
13. A device which converts non-electrical energy into electrical energy is called:  
(a) Source of emf (b) Transformer  
(c) Source of thermal energy (d) A.C motor
14. The rate at which electrical energy is converted into another form is called:  
(a) Potential difference (b) Electric power  
(c) Electric current (d) Electromotive force
15. A  $100\text{-W}$  bulb and a  $25\text{-W}$  bulb are designed for the same voltage. They have filaments of the same length and material. The ratio of the diameter of the  $100\text{-W}$  bulb to that of the  $25\text{-W}$  bulb is:  
(a) 4:1 (b) 2:1 (c)  $\sqrt{2}:1$  (d) 1:2

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Ans:	a	c	b	b	c	b	b	c	a	d	a	d	a	b	b

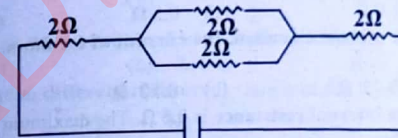
16. A 25 W, 220 V bulb and a 100 W, 220 V bulb are joined in series and connected to the mains. Which bulb will glow brighter?  
 (a) 25 W bulb (b) First 25 W bulb and then 100 W bulb  
 (c) 100 W bulb (d) Both will glow with same brightness
17. A heater uses 10 A when connected to 220 V line. If electrical energy costs 20 rupees per kilowatt-hour. The cost of running this heater for 10 hours is:  
 (a) 440 rupees (b) 330 rupees (c) 220 rupees (d) 110 rupees
18. Two bulbs of 500 W and 200 W rated at 230 V will have resistance ratio as:  
 (a) 4 : 25 (b) 2 : 5 (c) 25 : 4 (d) 5 : 2
19. Expression written as "V (Q/t)" represents:  
 (a) Work done (b) Electric energy  
 (c) Electric power (d) Electromotive force
20. The maximum power drawn from source depends on:  
 (a) Value of source resistance (b) Both source and load resistance  
 (c) Value of load resistance (d) Neither source or load resistance
21. A current of 4.8 ampere is flowing in a conductor. The number of electrons flowing per second through the conductor will be:  
 (a)  $3 \times 10^{19}$  electrons per second (b)  $7.68 \times 10^{20}$  electrons per second  
 (c)  $76.8 \times 10^{20}$  electrons per second (d)  $3 \times 10^{20}$  electrons per second
22. If  $n$  resistance, each of  $r$  ohm, when connected in parallel give an equivalent resistance of  $R$  ohm. If these resistance were connected in series, the combination would have a resistance in ohm, equal to:  
 (a)  $\frac{R}{n^2}$  (b)  $\frac{R}{n}$  (c)  $nR$  (d)  $n^2R$
23. The resistance of a conductor carrying a current of 2A, when potential difference across it is 20 V, is:  
 (a) 0 J  $\Omega$  (b) 1  $\Omega$  (c) 10  $\Omega$  (d) 40  $\Omega$
24. A piece of copper and a piece of germanium are cooled from the room temperature down to 77 K.  
 (a) The resistance of each of them increase  
 (b) The resistance of each of them decrease  
 (c) The resistance of copper increases and that of germanium decrease  
 (d) The resistance of copper decreases and that of germanium increase
25. Which of the following statement(s) is/are true about metals?  
 (a) Metals have positive temperature coefficient  
 (b) Metals have negative temperature coefficient  
 (c) Metals have zero temperature coefficient  
 (d) Metals have infinite temperature coefficient
26. Several resistors are connected in series, the resistance of their equivalent resistor will be:  
 (a) Greater than any of individual resistor  
 (b) Smaller than any individual resistor  
 (c) Equal to largest individual resistor  
 (d) Equal to smallest individual resistor
27. The amount of energy obtained by a source with power of 1KW in one hour is equal to one:  
 (a) KWh (b) eV (c) J (d) Calorie
28. If a wire of resistance  $R$  is melted and recasted to half of its length, then the new resistance of the wire will be:  
 (a)  $\frac{R}{4}$  (b)  $\frac{R}{2}$  (c)  $R$  (d)  $2R$

Sr.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.
Ans:	a	a	b	c	b	a	d	c	d	a	a	a	a

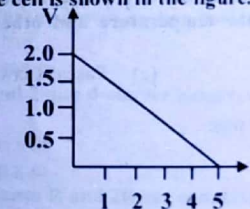
29. In the given circuit the current drawn through battery is:



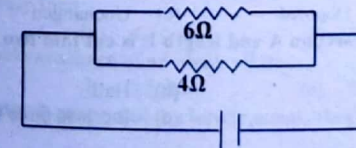
- (a) 0.5 A (b) 1.5 A (c) 1.0 A (d) 2.0 A
30. A nichrome wire 50 cm long and one square millimeter cross-section carries a current of 4A when connected to a 2V battery. The resistivity of nichrome wire in ohm meter is:  
 (a)  $1 \times 10^{-6}$  (b)  $4 \times 10^{-7}$  (c)  $3 \times 10^{-7}$  (d)  $2 \times 10^{-7}$
31. The resistivity of wire:  
 (a) Increase with the length of wire  
 (b) Decreases with the area of cross section  
 (c) Decreases with the length and increase with the cross section of wire  
 (d) None of the above statement is correct
32. The equivalent resistance of the circuit shown in the figure is:



- (a) 8  $\Omega$  (b) 6  $\Omega$  (c) 5  $\Omega$  (d) 4  $\Omega$
33. The effective resistance of two wire in parallel is  $\frac{6}{5} \Omega$ . If the resistance of one wire is 3  $\Omega$ , that of other wire:  
 (a) 2  $\Omega$  (b) 5  $\Omega$  (c) 3  $\Omega$  (d) 6  $\Omega$
34. For a cell, the graph between the potential difference across the terminals of the cell and the current drawn from the cell is shown in the figure. The emf and the internal resistance of the cell are:



- (a) 2V, 0.5  $\Omega$  (b) 2V, 0.4  $\Omega$  (c) 2V, 5  $\Omega$  (d) 5V, 2  $\Omega$
35. In the circuit shown below, the power developed in the 6  $\Omega$  resistor is 6 watt. The power in watt developed in the resistor 4  $\Omega$  is:



Sr.	29.	30.	31.	32.	33.	34.	35.
Ans:	a	a	d	c	a	b	b

36. Two bulbs one of 50 watt and another of 25 watt are connected in series the mains. The ratio of the currents through them is:

- (a) 2:1 (b) 1:2 (c) 1:1 (d) Without voltage cannot be calculated

37. For which of the following the resistance decreases on increasing the temperature:

- (a) Copper (b) Tungsten (c) Germanium (d) Aluminum

38. A certain wire has a resistance  $R$ . The resistance of another wire identical with the first except having twice its diameter is:

- (a)  $2R$  (b)  $0.25R$  (c)  $4R$  (d)  $0.5R$

39. The resistance of a wire is 20 ohm. It is so stretched that the length becomes three times, then the new resistance of the wire will be:

- (a) 6.67 ohm (b) 60 ohm (c) 120 ohm (d) 180 ohm

40. Three resistors each of 2 ohm are connected together in a triangular shape. The resistance between any two vertices will be:

- (a)  $\frac{4}{3}$  ohm (b)  $\frac{3}{4}$  ohm (c) 3 ohm (d) 6 ohm

41. A battery of 10 V and internal resistance  $0.5\Omega$  is connected across a variable resistor  $R$ . The value of  $R$  for which power delivered is maximum equal to:

- (a)  $0.25\Omega$  (b)  $1.0\Omega$  (c)  $0.5\Omega$  (d)  $2.0\Omega$

42. The emf of a cell is 1.5 V. When it is short circuited, the current of 6A flows. The internal resistance of cell is:

- (a)  $0.25\Omega$  (b)  $0.75\Omega$  (c)  $0.50\Omega$  (d)  $1.0\Omega$

43. The emf of a battery is 2 V and its internal resistance is  $0.5\Omega$ . The maximum power which it can deliver to any external circuit will be:

- (a) 8 watt (b) 4 watt (c) 2 watt (d) 1 watt

44. The current in a resistor is 8.0 mA. What charge flows through the resistor in 0.020 s?

- (a) 0.16 mC (b) 4.0 mC (c) 1.6 mC (d) 0.40 mC

45. Which equation represents the maximum output power

- (a)  $P = VI$  (b)  $P = I^2R$  (c)  $P = V^2/R$  (d) All of these

46. The current passing through a conductor is directly proportional to the potential difference applied across its terminals, provided the temperature and other physical conditions of the conductor does not change:

- (a) Gauss's law (b) Lenz law (c) Pascal's law (d) Ohm's law

47. Electric power is:

- (a) Rate of electric work done per unit time  
(b) Voltage per unit time  
(c) Electric charge per unit time  
(d) Current per unit time

48. A 250V bulb passes a current of 0.3A. Calculate the power in the lamp.

- (a) 50W (b) 75W (c) 100 W (d) 990W

49. The length of a conductor is halved, its resistance will be:

- (a) Halved (b) Doubled (c) Unchanged (d) Quadrupled

50. A wire of uniform area of cross-section  $A$  and length  $L$  is cut into two equal parts, the resistivity of each part is

- (a) Doubled (b) Half  
(c) Remains the same (d) Increase three times

Sr.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	c	b	d	a	c	a	c	a	d	d	a	b	a	c

1. In the following circuit, the resistance between points X and Y is:



- (a) 200Ω (b) 100Ω (c) 15Ω (d) 5.1Ω

2.  $1 \times 10^7$  electrons pass through a conductor in  $1\mu s$ . The current in (mA) through the conductor is:

- (a)  $1.6 \times 10^{-6}$  (b)  $1.6 \times 10^{-3}$  (c)  $1.6 \times 10^{-4}$  (d)  $1.6 \times 10^{-5}$

3. The internal resistance of a cell can be expressed:

- (a)  $\frac{E-V}{R}$  (b)  $\frac{E}{I} IR$  (c)  $\frac{E-V}{I}$  (d)  $E - \frac{1}{R}$

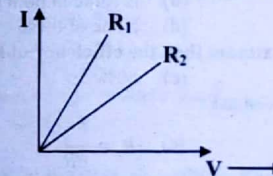
4. The terminal potential difference of a cell of emf  $E$  when short circuit is:

- (a)  $E$  (b)  $\frac{E}{2}$  (c) Zero (d)  $\frac{E}{3}$

5. The quantity of charge required to provide a current of 10A for 1 hour is:

- (a) 3600 C (b) 360 C (c) 36000 C (d) 360000 C

6. I-V graph for two different resistors is shown in the figure below then:



- (a)  $R_1 > R_2$  (b)  $R_1 < R_2$  (c)  $R_1 = R_2$  (d)  $R_1 = 2R_2$

7. When the length and area of cross-section both are doubled, then its resistance:

- (a) Will become half (b) Will be doubled  
(c) Will remains same (d) Will become four times

8. A wire 100 cm long and 2 mm diameter has a resistance of 0.7 ohm, the electrical resistivity of the material is:

- (a)  $4.4 \times 10^{-6}$  ohm x m (b)  $2.2 \times 10^{-6}$  ohm x m  
(c)  $1.1 \times 10^{-6}$  ohm x m (d) 0.11 A

9. Two wires with resistance  $R$  and  $2R$  are connected in parallel, the ratio of heat generated in  $2R$  and  $R$  is:

- (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1

10. Two bulb are working in parallel order. Bulb A is brighter than bulb B. If  $R_A$  and  $R_B$  are their resistance respectively then:

- (a)  $R_A > R_B$  (b)  $R_A < R_B$  (c)  $R_A = R_B$  (d) None of these

11. The value of internal resistance of an ideal cell is:

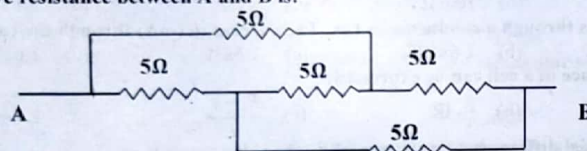
- (a) Zero (b)  $0.5\Omega$  (c)  $1\Omega$  (d) Infinity

12. If a high power heater is connected to electric mains, then the bulb in the house become dim, because there is a:

- (a) Current drop (b) Potential drop (c) No current drop (d) No potential drop

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Ans:	b	a	c	c	b	c	b	b	b	b	a	b

13. A 60 watt bulb operates on 220 V supply. The current flowing through the bulb is:  
 (a)  $\frac{11}{3}$  amp (b)  $\frac{3}{11}$  amp (c) 3 amp (d) 6 amp
14. The resistance of a wire at temperature  $t^\circ\text{C}$  and  $0^\circ\text{C}$  are related by:  
 (a)  $R_t = R_0(1+\alpha t)$  (b)  $R_t = R_0(1-\alpha t)$  (c)  $R_t = R_0^2(1+\alpha t)$  (d)  $R_t = R_0^2(1-\alpha t)$
15. Find three equal resistors, how many different combination of all the three resistors can be made:  
 (a) Six (b) Five (c) Four (d) three
16. The potential difference between head and tail of electric eel can be up to:  
 (a) 400 V (b) 600 V (c) 500 V (d) 700 V
17. Effective resistance between A and B is:



- (a) 15 Ω (b) 5 Ω (c)  $5\frac{5}{2}$  Ω (d) 20 Ω
18. Two bulb one of 25W, 220V and other of 100W, 220V are connected in parallel across the mains of 220V. The current:  
 (a) In 25W bulb is more (b) Is same in both bulbs  
 (c) In 100W bulb is more (d) None of these
19. When the power transfer to the load is maximum then the efficiency of battery is:  
 (a) 100% (b) 25% (c) 50% (d) 75%
20. The value of maximum output power is given as:  
 (a)  $P = \frac{E^2}{R}$  (b)  $P = \frac{4E^2}{R}$  (c)  $P = \frac{E^2}{4R}$  (d)  $P = \frac{E^2}{R^2}$
21. A conductor of resistance of 3Ω is stretched uniformly till its length is doubled. The wire is now bent in the form of an equilateral triangle. The effective resistance between the ends of any side of the triangle in ohm is:  
 (a)  $\frac{9}{2}$  (b) 2 (c)  $\frac{8}{3}$  (d) 1
22. The resistance of a piece of wire is 24Ω. It is bent to form an equilateral triangle. What is the equivalent resistance between any two corners of the triangles?  
 (a) 3.3 Ω (b) 4.0 Ω (c) 2.0 Ω (d) 5.3 Ω
23. A piece of wire of resistance 4Ω is bent through  $180^\circ$  at its mid-point and the two halves are twisted together. Then the resistance is:  
 (a) 8Ω (b) 1Ω (c) 2Ω (d) 5Ω
24. The electric resistance of a certain wire of iron is R. If its length and radius are both doubled, then:  
 (a) The resistance will be halved and the specific resistance will remain unchanged  
 (b) The resistance will be halved and the specific resistance will be doubled  
 (c) The resistance and the specific resistance will both remain unchanged  
 (d) The resistance will be doubled and the specific resistance will be halved
25. A wire has resistance 16Ω. It is bent in the form of a circle. The effective resistance between the two points on any diameter of the circle is:  
 (a) 4Ω (b) 32Ω (c) 10Ω (d) 24Ω

Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
Ans:	b	a	c	b	b	c	c	c	c	d	b	a	a

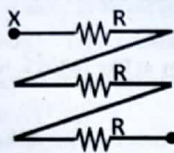
26. Two resistors of 15Ω and 30Ω are connected in parallel. What should be the value of R to be connected in series with the other two so that the net resistance will be 20Ω?  
 (a) 5Ω (b) 10Ω (c) 15Ω (d) 120Ω
27. In SI unit,  $\text{J C}^{-1}$  equal to:  
 (a) Volt (b) Pascal (c) Newton (d) Joule
28. A 50 W bulb is connected in series with a room heater. If now 50 W bulb is replaced by 100 W bulb. The heater output will:  
 (a) Increase (b) Remain same (c) Decrease (d) Heater will burn out
29. If the power company sells electrical energy at Pkr 18/kWh, how much does it cost to run 100 W power for 3 hours:  
 (a) Pkr 5.4 (b) Pkr 8.8 (c) Pkr 6.7 (d) Pkr 2.5
30. A 2 kW boiler used for 1 h energy per day consumes the following electrical energy in 30 days:  
 (a) 60 units (b) 120 units (c) 15 units (d) 80 units
31. The effective wattage of 100 W, 60 W and 40 W lamps connected in series, is equal to:  
 (a) 200 W (b) 124 W (c) 47.8 W (d) 19.3 W
32. A battery has an emf of 24 V and an internal resistance of 2.5 Ω. When an external 5.5Ω resistor is connected across the terminals of the battery, the potential difference between the terminals will be:  
 (a) 12.5 V (b) 13.5 V (c) 18.5 V (d) 16.5 V
33. A total charge of 100 C flows through a 12 watt bulb in a time of 50 second. What is the potential difference across the bulb during this time?  
 (a) 0.12 V (b) 6.0 V (c) 2.0 V (d) 24 V
34. Two bulbs one of 35 W, 220 V and other of 70 W, 220 V are connected in parallel across the mains of 220 V. The current:  
 (a) In 35 W bulb is lesser (b) Is same in both bulbs  
 (c) In 70 W bulb is lesser (d) None of these
35. Which of the following expression is true?  
 (a) 1 watt = (1 ohm) x (1 ampere) (b) 1 watt = (1 volt) x (1 ampere)  
 (c) 1 watt = (1 ohm) x (1 volt) (d) 1 watt = (1 ampere) x (1 ohm)<sup>2</sup>
36. The amount of energy obtained by a source with power of 1 kilowatt in one hour is equal to one:  
 (a) Kilowatt hour (b) Electron volt (c) Joule (d) Calorie
37. Find the resistance of voltage of the circuit is 45 volts and current 30 Amp?  
 (a) 1.6 ohm (b) 1.5 ohm (c) 1.7 ohm (d) 1.8 ohm
38. Which of the following can have negative temperature coefficient?  
 (a) Compounds of silver (b) Liquid metals (c) Metallic alloys (d) Electrolytes
39. Four wires of same material, the same cross-sectional area and the same length when connected in parallel give a resistance of 0.25 ohms. If the same four wires are connected in series the effective resistance will be  
 (a) 1 ohm (b) 2 ohm (c) 3 ohm (d) 4 ohm
40. Volts / Ampere = \_\_\_\_\_  
 (a) Ohm (b) Pascal (c) Ohm meter (d) None of these
41. A 200 W bulb operates in a 220V circuit. Find the current.  
 (a) 0.9 Amp (b) 2 Amp (c) 0.6 Amp (d) 3 Amp
42. If I, R and t are the current, resistance and time respectively, then according to Joule's law heat produced will be proportional to  
 (a)  $I^2 R t$  (b)  $I^2 R f$  (c)  $I^2 R^2 t$  (d)  $I^2 R^2 t^2$
43. SI unit of resistivity is  
 (a) Ohm (b) Ohm meter (c) Ohm/meter (d) Meter/ohm

Sr.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	b	a	c	a	a	d	d	b	a	b	a	b	d	d	a	a	a	b

44. The resistance of a superconductor is:

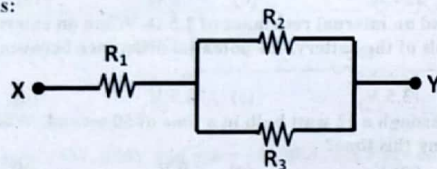
- (a) Finite (b) Infinite  
(c) Zero (d) Changes with every conductor

45. Three resistors each having value 'R' are connected as shown in figure. What is the equivalence resistance between 'X' and 'Y'?



- (a)  $3R$  (b)  $R$  (c)  $R/3$  (d)  $R^3$

46. Three resistors of resistance  $R_1$ ,  $R_2$  and  $R_3$  are connected as shown in figure. Equivalence resistance is:



- (a)  $R_1 + R_2 + R_3$  (b)  $\frac{R_1 + R_2 + R_3}{R_1 R_2}$  (c)  $\frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1 + R_2}$  (d)  $\frac{R_1 R_2 R_3}{R_2 R_3}$

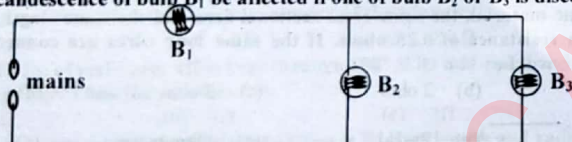
47. The length and radius of an electric resistance of a certain wire are doubled simultaneously, then the:

- (a) Resistance will be doubled and specific resistance will be halved  
(b) Resistance will be halved and specific resistance will remain unchanged  
(c) Resistance will be halved and the specific resistance will be doubled  
(d) Resistance and specific resistance will both remain unchanged

48. Resistivity of a wire is  $\text{ohm-m}$  if 0.75 A current flows through it by applying 1.5 V potential difference, take length and cross section as 5m and  $2.5 \times 10^{-7} \text{ m}^2$ :

- (a)  $1 \times 10^{-7}$  (b)  $2.63 \times 10^{-8}$  (c)  $19 \times 10^{-8}$  (d)  $7.85 \times 10^{-8}$

50. Three bulbs  $B_1$ ,  $B_2$  and  $B_3$  are connected to the mains as shown in the figure given below. How will the incandescence of bulb  $B_1$  be affected if one of bulb  $B_2$  or  $B_3$  is disconnected from the circuit?



- (a) no change in incandescence  
(b) Bulb  $B_1$  will become brighter  
(c) Bulb  $B_1$  will become less bright  
(d) Bulb  $B_2$  will become less bright

50. The resistance of a conductor at absolute zero (0 K) is:

- (a) Almost zero (b) Almost infinite  
(c) No prediction at all (d) May increase or decrease

Sr.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	a	c	b	a	c	a

## PRACTICE TEST NO. 4

- Resistivity of a substance is defined as the resistance of a ..... of that substance:  
(a) Meter (b) Meter square (c) Meter cube (d) Centimeter
- Value of current in a short circuit is \_\_\_\_\_.  
(a) Infinite (b) Zero (c) Minimum (d) Maximum
- Resistivity of a wire is \_\_\_\_\_ ohm-m if 0.75 A current flows through it by applying 1.5 V potential difference, take length and cross section as 5m and  $2.5 \times 10^{-7} \text{ m}^2$ .  
(a)  $1 \times 10^{-7}$  (b)  $2.63 \times 10^{-8}$  (c)  $19 \times 10^{-8}$  (d)  $7.85 \times 10^{-8}$
- In a conductor, if 6-coulomb charge flows for 2 seconds. The value of electric current will be  
(a) 3 amp (b) 2 amp (c) 3 volts (d) 2 volts
- In series circuit, current remains  
(a) Same (b) Different (c) Sometime same sometimes different (d) None of them
- Which of the following has a negative temperature coefficient of resistance?  
(a) Tungsten (b) Carbon (c) Nichrome (d) Platinum
- Correct form of ohm's law  
(a)  $I = VR$  (b)  $I \propto V$  (c)  $V = IR$  (d) Both B & C
- The SI unit for resistance is?  
(a) Ohm (b) Ampere (c) Watt (d) Volts
- If the load resistance is less or greater than the source resistance, then power delivered to the load will be;  
(a) Zero (b) Less than maximum (c) Maximum (d) infinite
- A class has ten 25 W compact fluorescent lamps. If these lamps are turned on for 10 hours every day, their energy consumption in 20 days is:  
(a) 1 kWh (b) 10 kWh (c) 5 kWh (d) 50 kWh
- In the presence of internal resistance of the source. Which one of the following relations between potential difference (V) and e.m.f (E) is correct? (when source is giving current to external resistance)  
(a)  $E = 0$  (b)  $E > V$  (c)  $E = V$  (d)  $E < V$
- Four equal resistors when connected in series dissipate 5 W power. If they are connected in parallel, the power dissipated will be:  
(a) 20 W (b) 60 W (c) 40 W (d) 80 W
- A battery of emf 20 V and internal resistance  $r$  is connected across external resistance  $R$ . What is the observed potential difference across the terminals of the battery when external resistance  $R$  is made equal to internal resistance  $r$ :  
(a) 20 V (b) 15 V (c) 10 V (d) 5 V
- An iron is rated at 550 W. How much would it cost to operate it for 2.5 hours at PKR 20/kWh?  
(a) PKR 27.5 (b) PKR 47.5 (c) PKR 37.5 (d) PKR 57.5
- The source of e.m.f transfers its maximum power to the external circuit when ( $r$ =internal resistance,  $R$ = load resistance):  
(a)  $r = 0$  (b)  $r < R$  (c)  $R = r$  (d)  $r > R$
- A 200 W bulb  $B_1$ , a 150 bulb  $B_2$  and a 75 W bulb  $B_3$  are connected in series across a 240 V source. Now  $P_1$ ,  $P_2$  and  $P_3$  are the output powers of bulbs  $B_1$ ,  $B_2$  and  $B_3$  respectively, then:  
(a)  $P_1 > P_2 = P_3$  (b)  $P_1 < P_2 = P_3$  (c)  $P_1 > P_2 > P_3$  (d)  $P_1 < P_2 < P_3$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Ans:	c	d	a	a	a	b	d	a	b	d	b	d	c	a	c	d

17. Pick out the wrong statement:

- (a) In a simple battery circuit, the point of lowest potential is the negative terminal of the battery  
 (b) The resistance of an incandescent lamp is greater when the lamp is switched off  
 (c) An ordinary 100 W lamp has less resistance than a 60 W lamp.  
 (d) The heat developed in a uniform wire increase directly as the resistance of the wire used is increased

18. Two electric bulbs whose resistances are in the ratio of 1:3 are connected in series. The powers dissipated in them have the ratio:

- (a) 1:1 (b) 1:3 (c) 1:6 (d) 3:1

19. The power rating of an electric motor which draws a current of 4.25 A, when operated at 200 V, is nearly:

- (a) 425 W (b) 750 W (c) 525 W (d) 850 W

20. In 1 minute, 1 kW electric fire uses 10 times as much energy as a:

- (a) 1 W LED (b) 100 W bulb (c) 10 W LED (d) 1000 W bulb

21. Three 60 W bulbs are in parallel across the 110 V power line. If one bulb burns out:

- (a) There will be heavy current in main line  
 (b) Rest of the two bulbs will stop glowing  
 (c) Rest of the two bulbs will glow with initial brightness  
 (d) All bulbs will become short circuit

22. If the electromotive force of the battery is 5 V, the total energy supplied by the battery to unit coulomb charge is:

- (a) 2.5 Joules (b) 1 Joule (c) 5 Joules (d) 10 Joules

23. The specific resistance of manganin is  $50 \times 10^{-8} \Omega \text{ m}$ . What is the resistance of a cube of length 50 cm will be:

- (a)  $10^{-6} \Omega$  (b)  $2.5 \times 10^{-5} \Omega$  (c)  $10^{-8} \Omega$  (d)  $5 \times 10^{-4} \Omega$

24. A piece of copper is to be shaped into a conductor of minimum resistance. The possible values of length and diameter are:

- (a)  $l, d$  (b)  $2l, d$  (c)  $\frac{l}{2}, 2d$  (d)  $2l, \frac{d}{2}$

25. What is the number of equal parts into which a conductor having a resistance  $R_0 = 100 \Omega$  should be cut to obtain the resistance  $R = 1 \Omega$  if the parts are connected in parallel?

- (a) 5 (b) 10 (c) 20 (d) 2

26. The example of non-ohmic resistance is:

- (a) Copper wire (b) Carbon resistance  
 (c) Silver wire (d) Tungsten wire

27. What is the unit of temperature coefficient?

- (a)  $^{\circ}\text{C}^{-1}$  (b)  $\Omega^{\circ}\text{C}$  (c)  $^{\circ}\text{C}$  (d)  $\Omega^{\circ}\text{C}$

28. When  $2 \Omega$ ,  $4 \Omega$  and  $6 \Omega$  resistances are connected in parallel, their resultant resistance will be:

- (a)  $12 \Omega$  (b)  $\frac{11}{12} \Omega$  (c)  $\frac{12}{11} \Omega$  (d) Data is insufficient

29. Two electric bulbs rated as (P1, V) and (P2, V) are connected in series across V source. Then the total power dissipation by combination is:

- (a)  $P_1 + P_2$  (b)  $\sqrt{P_1 P_2}$  (c)  $\frac{P_1 P_2}{P_1 + P_2}$  (d)  $\frac{P_1 + P_2}{P_1 P_2}$

30. If two electric bulbs have 40 W and 60 W rating at 220V, then the ratio of their resistance will be:

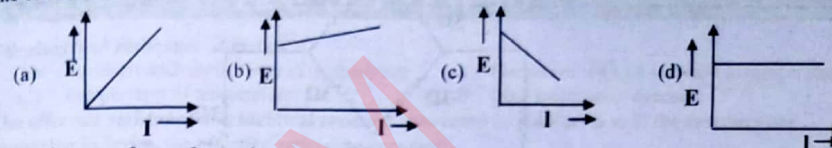
- (a) 3:2 (b) 2:3 (c) 3:4 (d) 4:3

31. A hand drill draws 4 A and has a resistance  $14.6 \Omega$ . What power does it use?

- (a) 234 W (b) 184 W (c) 134 W (d) 284 W

Sr.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
Ans:	b	b	d	b	c	c	a	c	b	d	a	c	c	a	a

32. The emf E of a cell varies with the current drawn from the cell according to the graph:



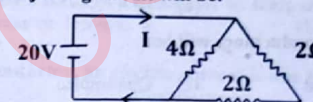
33. The resistance of a conductor increases with

- (a) Increase in length (b) Increase in temperature  
 (c) Decrease in cross-sectional area (d) All of these

34. The terminal potential difference of a cell is greater than its emf it is:

- (a) Being discharged (b) In open circuit  
 (c) Being charged (d) Either charge or discharge

35. The current in the adjoining circuit will be:



- (a) 0.1 A (b) 0.5 A (c) 10 A (d) 20 A

36. The electric bulb have tungsten filaments of same lengths. If one of them gives 60 watt and other 100 watt then,

- (a) 100 watt bulb has thicker filament  
 (b) 60 watt bulb has thick filament  
 (c) Both filament are of same thickness  
 (d) It is possible to get different wattage unless the lengths are different

37. Two identical heaters rated 220 volt, 1000 watt are placed in series with each other across 220 volt lines. If resistance do not change with temperature then the combined power is:

- (a) 1000 watt (b) 2000 watt (c) 500 watt (d) 400 watt

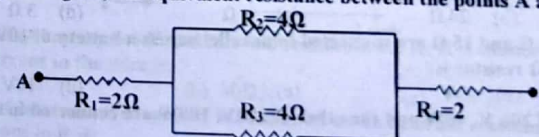
38. The equivalent resistance of resistors connected in series is always:

- (a) Equal to the mean of component resistors  
 (b) Less than the lowest of component resistors  
 (c) In between the lowest and the highest of component resistors  
 (d) Equal to sum of component resistor

39. By increasing the temperature, the specific resistance of a conductor and a semiconductor is:

- (a) Increase for both (b) Decrease for both  
 (c) Increase, decrease (d) Decrease, increase

40. In the given figure, the equivalent resistance between the points A and B is:



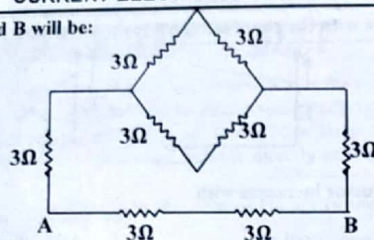
- (a)  $8 \Omega$  (b)  $6 \Omega$  (c)  $4 \Omega$  (d)  $2 \Omega$

41. A wire has resistance  $16 \Omega$ . It is bend in form of a square. The effective resistance between any two adjacent vertices of square is:

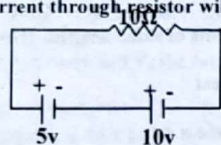
- (a)  $4 \Omega$  (b)  $6 \Omega$  (c)  $9 \Omega$  (d)  $12 \Omega$

Sr.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.
Ans:	d	d	c	c	b	c	d	c	b	a

42. Equivalent between A and B will be:



- (a) 2 ohm (b) 18 ohm (c) 6 ohm (d) 3.6 ohm
43. The resistance of a wire of uniform diameter  $d$  and length  $L$  is  $R$ . The resistance of another wire of the same material but diameter  $2d$  and length  $4L$  will be:
- (a)  $2R$  (b)  $R$  (c)  $\frac{R}{2}$  (d)  $\frac{R}{4}$
44. The length of the wire is doubled. Its conductance will be:
- (a) Unchanged (b) Halved (c) Quadrupled (d)  $\frac{1}{4}$  of the original value
45. In the diagram shown, the current through resistor will be:



- (a)  $\frac{1}{3}A$  (b)  $\frac{3}{2}A$  (c)  $\frac{2}{3}A$  (d)  $\frac{4}{3}A$
46. If  $R_1$  and  $R_2$  are respectively the filament resistance of a 400W bulb and 200W bulb, designed to operate on the same voltage, then:
- (a)  $R = 2R_2$  (b)  $R_2 = 4R_1$  (c)  $R_2 = 2R_1$  (d)  $R_1 = 4R_2$
47. The resistance of a wire  $R$  is cut into four equal parts and these parts are connected side by side. The effective resistance becomes:
- (a)  $\frac{R}{2}$  (b)  $\frac{R}{8}$  (c)  $\frac{R}{4}$  (d)  $\frac{R}{16}$
48. A wire has a resistance of 12 ohm. It is bent in the form of a circle. The effective resistance between the two points on any diameter of circle is:
- (a) 12  $\Omega$  (b) 24  $\Omega$  (c) 6  $\Omega$  (d) 3  $\Omega$
49. Three resistors of 5  $\Omega$ , 10  $\Omega$  and 15  $\Omega$  are connected in parallel across a battery of 10V. The potential drop across 10  $\Omega$  resistor is:
- (a) 2V (b) 5V (c) 3V (d) 10V
50. Two electric bulbs, one of 200 V, 40W and the other of 200V, 100W are connected in a house wiring circuit:
- (a) They have equal currents through them
- (b) The resistance of filaments in both the bulbs is same
- (c) The resistance of filament in 40W bulb is more than the resistance in 100W bulb
- (d) The resistance of the filament in 100 W bulb is more than the resistance in 40W bulb

Sr.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	b	b	b	c	d	d	d	c

## PRACTICE TEST NO. 5

- The electrical resistance of metals:
  - Increases with an increase in temperature
  - Decreases with an increase in temperature
  - Independent of temperature
  - May increase or decrease
- The effective resistance of  $n$  identical resistors connected in parallel is  $x$ . If the resistors are connected in series, the effective resistance becomes:
  - $nx$
  - $\frac{x}{n}$
  - $n^2x$
  - $\frac{x}{n^2}$
- Three resistances 4  $\Omega$  each are connected in the form of an equilateral triangle. The effective resistance between two corners is:
  - 8  $\Omega$
  - 12  $\Omega$
  - $\frac{3}{8} \Omega$
  - $\frac{8}{3} \Omega$
- When a current flows through a conductor its temperature:
  - May increase or decrease
  - Remains same
  - Decrease
  - Increase
- Through a semiconductor, an electric current is due to drift of:
  - Free electrons
  - Free electrons and holes
  - Positive and negative ions
  - protons
- Two wires A and B of same material and same length have radius  $r$  and  $2r$ . If resistance of wire A is 32  $\Omega$ , then resistance of B will be:
  - 8  $\Omega$
  - 16  $\Omega$
  - 32  $\Omega$
  - 128  $\Omega$
- A 60 watt bulb carries a current of 0.5 amp. The total charge passing through it in 1 hour is:
  - 3600 C
  - 3000 C
  - 2400 C
  - 1800 C
- The brightness of a bulb will be reduced if a resistance is connected in:
  - Series with it
  - Parallel with it
  - Series or parallel with it
  - Brightness of bulb cannot be reduced
- Two electric lamp of 40 watt each are connected in parallel. The power consumed by the combination will be:
  - 20 watt
  - 80 watt
  - 500 watt
  - 100 watt
- Which of the adjoining graph represents ohmic device.
 

(a)

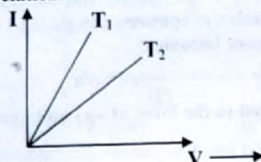
(b)

(c)

(d)
- The emf of battery is 6 V and internal resistance 0.5  $\Omega$ . It is connected to a wire of resistance 2  $\Omega$ . The current in the wire is:
  - 3 A
  - 0.33A
  - 2.4 A
  - 6 A
- A cell of internal resistance ' $r$ ' is connected on an external resistance  $R$ . The current will be maximum in  $R$  if:
  - $R=r$
  - $R < r$
  - $R > r$
  - $R = \frac{r}{2}$
- The positive temperature coefficient of resistance is for:
  - Carbon
  - Germanium
  - Copper
  - Silicon

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Ans:	a	c	d	d	b	a	d	a	b	a	c	a	c

14. A cell whose emf is 2V and internal resistance is  $0.1\ \Omega$ , is connected with a resistance of  $3.9\ \Omega$ , the voltage across the cell terminal will be:  
 (a) 0.5 V (b) 1.9 V (c) 1.95 V (d) 2V
15. The voltage V and current 'I' graph for a conductor at two different temperatures  $T_1$  and  $T_2$  are shown in the figure. The relation between  $T_1$  and  $T_2$  is:



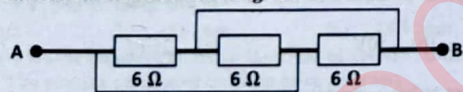
- (a)  $T_1 > T_2$  (b)  $T_1 \approx T_2$  (c)  $T_1 = T_2$  (d)  $T_1 < T_2$
16. Which of the following is correct expression of power?  
 (a)  $P = I^2 R$  (b)  $P = VI$  (c)  $P = \frac{V^2}{R}$  (d) All of these
17. An electric bulb is rated 220 V, 200 W. The power dissipated by it when operated at 110 V is:  
 (a) 50 W (b) 25 W (c) 75 W (d) 90 W
18. Three equal resistors connected to parallel have equivalent resistance  $R/9$ . When they are connected in series then the equivalent resistance is:  
 (a)  $R/3$  (b)  $R$  (c)  $2R$  (d)  $3R$
19. The resistance of insulators:  
 (a) Increase with increase in temperature  
 (b) Decrease with increase in temperature  
 (c) Remain same with increase in temperature  
 (d) Becomes infinite with increase in temperature
20. The conductivity of a super conductor is:  
 (a) Infinite (b) Very large (c) Very small (d) Zero
21. What carries current in an electrolyte?  
 (a) Electrons only (b) -ve ions only (c) +ve ions only (d) Both +ve and -ve ions
22. If two wire made of the same material have lengths in the ratio 1:2 and the radii in the ratio 2:3, then the resistance are in the ratio of:  
 (a) 4:9 (b) 9:4 (c) 8:9 (d) 9:8
23. The maximum power is delivered to a circuit when source resistance is \_\_\_\_\_ load resistance:  
 (a) Greater than (b) Less than  
 (c) Equal to (d) Greater than or equal to
24. A 3 ohm resistor having 2 A current will dissipate the power of:  
 (a) 2 W (b) 6 W (c) 18 W (d) 12 W
25. Resistance of 220 V, 100 W lamp will be:  
 (a) 4.84 ohm (b) 484 ohm (c) 48.4 ohm (d) 48440 ohm
26. Two electric bulb whose resistances are in the ratio of 1:4 are connected in parallel to a constant voltage source. The powers dissipated in them have the ratio:  
 (a) 1:2 (b) 4:1 (c) 2:1 (d) 1:4
27. Three resistances  $2\ \Omega$ ,  $3\ \Omega$  and  $5\ \Omega$  are connected in parallel to a battery of 10 V and of negligible internal resistance. The potential drop across the  $3\ \Omega$  resistance will be:  
 (a) 2 V (b) 3 V (c) 5 V (d) 10 V

Sr.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	b	a	d	a	b	b	a	d	d	c	d	b	b	d

28. A 220 V and 700 W electric kettle and four 220 V and 100 W bulbs are connected in parallel. On connecting this combination with 220 V electric supply. The total current will be:  
 (a) 5.5 A (b) 6.9 A (c) 5.0 A (d) 0.2 A
29. A cell of emf  $E$  has internal resistance  $r$ . It is connected across external resistance of value  $x$ . The potential difference across the terminals of cell is  $E/2$ , then:  
 (a)  $x = r$  (b)  $x < r$  (c)  $x > r$  (d)  $x = 0$
30. Two electric bulbs rated as  $(P_1, V)$  and  $(P_2, V)$  are connected in series across  $V$ (volts) source. Then the total power dissipation by combination is:  
 (a)  $P_1 + P_2$  (b)  $\frac{P_1 P_2}{P_1 + P_2}$  (c)  $\sqrt{P_1 P_2}$  (d)  $\frac{(P_1 + P_2)}{P_1 P_2}$
31. The unit of electromotive force is:  
 (a) Newton (b) Watt (c) Joule (d) Volt
32. The electrical energy consumed by a 100 W bulb in 10 hour is:  
 (a) 1000 kWh (b) 10 kWh (c) 100 kWh (d) 1 kWh
33. Which of the following pair/pairs contain sources of emf only?  
 (a) Batteries and thermocouples (b) Batteries and transformers  
 (c) Solar cells and electric generator (d) Both A and C
34. Two 100 W, 220 V bulbs are first connected in series then in parallel. Power in each case respectively will be:  
 (a) 200 W, 160 W (b) 50 W, 200 W (c) 50 W, 100 W (d) 100 W, 50 W
35. Of the two bulbs in a house, one glows brighter than the other. Which of the two has larger resistance?  
 (a) Bright bulb (b) Dim bulb  
 (c) Both have same resistance (d) Brightness does not depend on resistance
36. If the power rating of a vacuum cleaner is 550 W, the current it draws in a 220V electric circuit is:  
 (a) 0.4 A (b) 2.5 A (c) 1.5 A (d) 3.7 A
37. Internal resistance of a battery is ..... ohm, if,  $E=10V$ ,  $V_t=9V$ ,  $I=1A$   
 (a) 1 (b) 0.1 (c) 0.01 (d) None of these
38. \_\_\_\_\_ relationship exists between current and voltage in terms of Ohm's law.  
 (a) Non linear (b) Varying (c) Linear (d) None of them
39. A resistance of 40 Ohms is attached to a circuit having current of 300 Amp. Find its voltage.  
 (a) 12000 volts (b) 15000 volts (c) 20000 volts (d) 300 volts
40. Terminal potential difference of a cell  
 (a) Increases with increase in its internal resistance  
 (b) Decrease with increase in internal resistance  
 (c) Is independent of its internal resistance  
 (d) None of these
41. If the conductor resistance is 50 ohm and the current passing through it is 5A. What is the value of potential difference?  
 (a) 150V (b) 50V (c) 250V (d) 15V
42. Ohm's law is true for  
 (a) Metallic conductors at low temperature  
 (b) Metallic conductors at high temperature  
 (c) For electrolytes, when current passes through them  
 (d) For diode when current flows

Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.
Ans:	d	c	b	d	d	d	B	b	b	a	c	a	b	c	a

43. The heat sensitive device whose resistivity changes very rapidly with change of temperature is called a:
- (a) Resistor (b) Super-conductor  
(c) Thermocouple (d) Thermistor
44. When the length of the conductor is doubled and the area of cross-section remain the same then its resistance:
- (a) Remains the same (b) Will be doubled  
(c) Will become half (d) Will increase by four times
45. If 1 ampere current will flow in 5m conductor for 1 hour the charge flow will be
- (a) 5C (b) 18000C (c) 1C (d) 3600C
46. A potential difference of 10V is applied across a conductor whose resistance is 2.5 ohm. What is the value of current flowing through it?
- (a) 4A (b) 2A (c) 6A (d) 10A
47. The specific resistance of a conductor increases with:
- (a) Increase in temperature  
(b) Increase in cross-sectional area  
(c) Decrease in length  
(d) Decrease in cross-sectional area
48.  $R_{eq} = R_1 + R_2 + R_3 + \dots + R_n$  is the combination in
- (a) Series (b) Parallel (c) Both a and b (d) None of these
49. Materials that have both metallic and non-metallic characteristics are called:
- (a) Semiconductor (b) Metal (c) Non metal (d) Organic compound
50. As compared to thin wires, thick wires have:
- (a) More resistance (b) No resistance (c) Less resistance (d) Same resistance
51. The battery of a pocket calculator supplies 0.35A at a potential difference of 6 volts. What is the power of the calculator?
- (a) 9 Watt (b) 2.1 Watt (c) 4 Watt (d) 7 Watt
52. An immersion heater of 400 watts kept on for 5 hours will consume electrical power of:
- (a) 2KWh (b) 20 KWh (c) 6KWh (d) 12KWh
53. The graphical representation of Ohm's law is:
- (a) Hyperbola (b) Ellipse (c) Parabola (d) Straight line
54. The specific resistance of a rod of copper as compared to that of thin wire of copper is:
- (a) Less (b) More  
(c) Same  
(d) Depends upon the length and area of cross-section of the wire
55.  $1/R_{eq} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}$  is the combination in
- (a) Series (b) Parallel (c) Both of them (d) None of them
56. Three 6  $\Omega$  are connected as shown in the diagram.

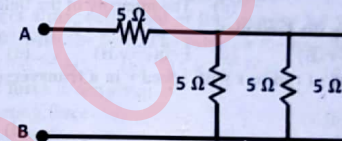


What is the resistance between points 'A' and 'B'?

- (a) 6  $\Omega$  (b) 16  $\Omega$  (c) 4  $\Omega$  (d) 2  $\Omega$

Sr.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.
Ans:	d	b	d	a	a	a	a	c	b	a	d	c	b	d

57. Which combinations of seven identical resistors each of 2  $\Omega$  gives rise to the resultant of 10/11  $\Omega$ ?
- (a) 5 parallel, 2 series (b) 3 parallel, 4 series  
(c) 4 parallel, 3 series (d) 2 parallel, 5 series
58. If a resistor having resistance 'R' is cut into three equal parts, then the equivalent of parallel combination is:
- (a)  $\frac{6}{R}$  (b)  $\frac{3}{R}$  (c)  $\frac{R}{9}$  (d)  $\frac{R}{3}$
59. The resistance of a piece of wire is 12  $\Omega$ . It is bent to form an equilateral triangle. What is the equivalent resistance between any two corners of the triangles?
- (a) 1.3  $\Omega$  (b) 4.0  $\Omega$  (c) 2.0  $\Omega$  (d) 2.7  $\Omega$
60. Total resistance between 'A' and 'B' in the given circuit is:



- (a) 5.6  $\Omega$  (b) 3.33  $\Omega$  (c) 0.33  $\Omega$  (d) 6.6  $\Omega$
61. Calculate the charge passing through the circuit if its current is 10 Amp and the recorded time is 15 seconds:
- (a) 1500 coulomb (b) 150 coulomb (c) 13400 coulomb (d) -140 coulomb
62. Coulomb per second is equivalent to:
- (a) Ampere (b) Farad (c) Henry (d) Watt
63. Calculate the time taken for the charges to complete the circuit if the total charges were 5000 Coulomb and the current of the circuit was 20 Amp?
- (a) 250 seconds (b) 350 seconds (c) 400 seconds (d) 500 seconds
64. Copper wire is used as connecting wire because:
- (a) Copper has high electrical resistivity (b) Copper has low electrical resistivity  
(c) Copper has low electrical conductivity (d) Copper has high value of elasticity
65. The fractional change in resistance per Kelvin is known as:
- (a) Coefficient in resistance (b) Temperature coefficient of resistance  
(c) Resistance (d) None of these

Sr.	57.	58.	59.	60.	61.	62.	63.	64.	65.
Ans:	d	c	d	d	b	a	a	b	b

## UNIT 08 &gt;&gt;

## ELECTROMAGNETISM

## PRACTICE TEST NO. 1

- The radius of curvature of the path of the charged particle in a uniform magnetic field is directly proportional to:
  - The charge on the particle
  - The momentum of the particle
  - The energy of the particle
  - The intensity of the field
- Lorentz force can be calculated by using the formula:
  - $F=q(E+v \times B)$
  - $F=q(E-v \times B)$
  - $F=q(E+v \cdot B)$
  - $F=q(E \times B+v)$
- An electron is moving on a circular path of radius  $r$  with speed  $v$  in a transverse magnetic field  $B$ .  $e/m$  for it will be:
  - $\frac{v}{Br}$
  - $\frac{B}{rv}$
  - $\frac{vr}{B}$
  - $Bvr$
- A charged particle enters a magnetic field  $B$  with its initial velocity making an angle of  $45^\circ$  with  $B$ . The path of the particle will be:
  - Straight line
  - Circle
  - Ellipse
  - Helix
- A charge moving with velocity  $v$  in  $x$ -direction is subjected to a field of magnetic induction in the negative  $X$ -direction. As a result, the charge will:
  - Remain unaffected
  - Start moving in a circular path  $y$ - $z$  plane
  - Retard along  $X$ -axis
  - Move along a helical path around  $X$ -axis
- A charge  $q$  is moving in a magnetic field then the magnetic force does not depend upon:
  - Charge
  - Mass
  - Velocity
  - Magnetic field
- Charge to mass ratio of neutron is:
  - $\frac{v}{Br}$
  - $\frac{2v}{Br}$
  - $\frac{2v}{B^2 r^2}$
  - Zero
- The magnetic flux is maximum when angle between magnetic field and area is:
  - $0^\circ$
  - $60^\circ$
  - $90^\circ$
  - $30^\circ$
- A unit of magnetic induction is:
  - $\text{Wb m}^{-2}$
  - $\text{Wb m}$
  - $\text{Wb A}^{-1} \text{m}^{-1}$
  - $\text{Wb}$
- An electron is moving in a circle of radius  $r$  in a uniform magnetic field  $B$ . Suddenly the field is reduced to  $B/2$ . The radius of the circle now becomes:
  - $r/2$
  - $r/4$
  - $2r$
  - $4r$
- An electron describes a circular orbit of radius  $2 \text{ cm}$  in a uniform magnetic field. If the speed of the electron is doubled, then the radius of the orbit will become:
  - $0.5 \text{ cm}$
  - $1.0 \text{ cm}$
  - $2.0 \text{ cm}$
  - $4.0 \text{ cm}$
- A proton and an  $\alpha$ -particle, accelerated through same potential difference, enter a region of uniform magnetic field normally. If the radius of proton orbit is  $10 \text{ cm}$ , then that of  $\alpha$ -particle's orbit is:
  - $10 \text{ cm}$
  - $20 \text{ cm}$
  - $10\sqrt{2} \text{ cm}$
  - $5\sqrt{2} \text{ cm}$
- If we double all the parameters of force acting on charge moving in magnetic field keeping  $\theta = 90^\circ$  (between magnetic field and velocity) then magnetic force becomes:
  - $\frac{1}{2}$  times
  - 2 times
  - 8 times
  - $\frac{1}{8}$  times
- A  $0.50 \text{ T}$  field over an area of  $2 \text{ m}^2$  which lies at angle of  $60^\circ$  to the field, then the magnetic flux is:
  - $0.50 \text{ weber}$
  - $0.75 \text{ weber}$
  - $2 \text{ weber}$
  - $0.866 \text{ weber}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	b	a	a	d	a	b	d	c	a	c	d	a	c	d

- The magnetic field outside the solenoid due to current is taken as :
  - Strong
  - Weak
  - Zero
  - Uniform
- A solenoid  $15 \text{ cm}$  long has  $300$  turns and a current of  $5 \text{ A}$  flows through it. What is the magnetic field outside the solenoid?
  - $0.65 \times 10^{-2} \text{ Wb m}^{-2}$
  - $4.4 \times 10^{-3} \text{ Wb m}^{-2}$
  - $1.3 \times 10^{-2} \text{ Wb m}^{-2}$
  - zero
- One tesla is equal to
  - $\text{NA}^{-1} \text{m}^{-1}$
  - $\text{N}^{-1} \text{Am}$
  - $\text{ANm}^{-1}$
  - $\text{NA}^{-1} \text{m}$
- A current carrying power line carries electronic current from south to north. What will be the direction of the magnetic field at a point above the wire?
  - East to west
  - North to south
  - West to east
  - South to north
- A proton enters a magnetic field of flux density  $3.0 \text{ Wb m}^{-2}$  with a velocity of  $4 \times 10^7 \text{ ms}^{-1}$  at an angle of  $30^\circ$  with the field. The force on the proton will be:
  - $2.4 \times 10^{-12} \text{ N}$
  - $24 \times 10^{-12} \text{ N}$
  - $9.6 \times 10^{-12} \text{ N}$
  - $0.96 \times 10^{-12} \text{ N}$
- The magnetic force is simply a:
  - Reflecting force
  - Restoring force
  - Deflecting force
  - Gravitational force
- By doubling the number of turns of the coil and making area of each turn half, the magnetic flux linked with coil is:
  - Doubled
  - Halved
  - Quartered
  - Same
- A solenoid is  $1.0 \text{ m}$  long and it has  $4250$  turns. If a current of  $5.0 \text{ A}$  is flowing through it, what is the magnetic field at its centre?
  - $5.4 \times 10^{-2} \text{ T}$
  - $2.7 \times 10^{-2} \text{ T}$
  - $1.35 \times 10^{-2} \text{ T}$
  - $0.075 \times 10^{-2} \text{ T}$
- A long solenoid has  $n$  turns per metre and current  $I \text{ A}$  is flowing through it. The magnetic field at the ends of the solenoid is:
  - $\frac{\mu_0 n I}{2}$
  - zero
  - $\mu_0 n I$
  - $2\mu_0 n I$
- Which, among the following quantities, is not affected by the magnetic field?
  - Moving charge
  - Charge in magnetic field
  - Current flowing in conductor
  - Stationary charge
- For which angle between area and magnetic field, flux is maximum
  - $0$  degree
  - $90$  degree
  - $45$  degree
  - $60$  degree
- Magnetic force between wires is inversely proportional to
  - Distance
  - Current on them
  - Charge on them
  - None of these
- Force on a moving charge in a uniform magnetic field will be maximum, when angle between  $v$  and  $B$  is
  - $0$
  - $30$
  - $60$
  - $90$
- One charge enters in magnetic field of  $2 \times 10^{-2} \text{ T}$  normally with specific charge  $10^8 \text{ C/kg}$  and velocity of  $10^7 \text{ m/s}$ . What will be the radius of circle?
  - $1 \text{ m}$
  - $0.5 \text{ m}$
  - $5 \text{ m}$
  - $10 \text{ m}$
- If 'A' is fundamental dimension of ampere then the dimension of magnetic field strength is:
  - $[\text{MT}^{-2} \text{A}^{-2}]$
  - $[\text{MT}^{-2} \text{A}^{-1}]$
  - $[\text{MT}^2 \text{L}^2 \text{A}^{-1}]$
  - $[\text{MLT}^2 \text{L}^{-2} \text{A}^{-2}]$

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
Ans:	c	c	a	a	c	c	d	b	a	d	b	a	d	c	b

30. If a charge particle enters in a region where electric and magnetic field are parallel to its motion, then it will:  
 (a) Deflect upwards (b) Deflect downward  
 (c) Speed up (d) Speed down
31. Magnetic field is very strong where field lines are:  
 (a) Zero (b) Far apart (c) Very close (d) None of these
32. If magnetic field is doubled then magnetic energy density becomes:  
 (a) Four times (b) Two times  
 (c) Three times (d) Six times
33. An object has mass and charge. It is moving in the direction of some field. Which type of field exerts a force on the object?  
 (a) Electric and magnetic fields only  
 (b) Magnetic and gravitational fields only  
 (c) Electric and gravitational fields only  
 (d) Electric, magnetic and gravitational fields
34. When a charge particle enters in the magnetic field perpendicular to the velocity of charge, followed path is:  
 (a) Circular (b) Parabolic (c) Elliptical (d) Hyperbolic
35. If magnetic field is given by  $B = (2i + 3j - 8k)$  and a loop of area  $10 \text{ m}^2$  is placed in field in y-z plane, max flux will be:  
 (a) -20 wb (b) 30 wb (c) 20 wb (d) 80 wb
36.  $e/m =$   
 (a)  $mv/Br$  (b)  $v/Br$  (c)  $r/Bv$  (d)  $B/vr$
37. What is the angular frequency during the circular motion when a charge  $q$  is moving in magnetic field  $B$ .  
 (a)  $qm/B$  (b)  $qB/m$  (c)  $m/qB$  (d)  $qmB$
38. The strength of the magnetic field at a point  $r$  near a long straight current carrying wire is  $B$ . The field at a distance  $\frac{r}{2}$  will be:  
 (a)  $\frac{B}{2}$  (b)  $\frac{B}{4}$  (c)  $2B$  (d)  $4B$
39. An electron is moving along negative x-axis. To get it moving on an anti-clockwise circular path in x-y plane, a magnetic field is applied:  
 (a) Along positive y-axis (b) Along negative x-axis  
 (c) Along positive z-axis (d) Along negative z-axis
40. Magnetic flux will be maximum when:  
 (a) Angle between  $B$  and  $A$  is  $45^\circ$   
 (b)  $B$  lies parallel to the plane of area  $A$   
 (c)  $B$  lies perpendicular to the plane of area  $A$   
 (d)  $B$  is a null vector
41. A charge is projected with  $20 \text{ ms}^{-1}$  velocity in a magnetic field of  $5 \text{ T}$  at an angle of  $30^\circ$ . If force of  $4.8 \times 10^{-17} \text{ N}$  is exerted on the charge, then value of charge will be:  
 (a)  $1.6 \times 10^{-19} \text{ C}$  (b)  $2.7 \times 10^{-19} \text{ C}$  (c)  $4.8 \times 10^{-19} \text{ C}$  (d)  $9.6 \times 10^{-19} \text{ C}$
42. An electron is moving along the line of force in magnetic field  $B$  with velocity  $u$ , then maximum force acting on the charge is given by  
 (a)  $Bue$  (b)  $Bu/q$  (c)  $Bq/u$  (d) 0
43. If magnetic field vector is  $B = (i + 2j + k)$  and area vector is  $(2i + j + k)$  then flux related to this is:  
 (a) 4 Wb (b) 5 Wb (c) 6 Wb (d) 7 Wb

Sr.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	c	c	a	a	a	c	b	b	c	c	c	d	a	b

44. What is the radius of circular path, If particle has mass  $m$  and charge  $q$ :  
 (a)  $r = qb/m$  (b)  $r = mv/B$  (c)  $r = mv/qB$  (d)  $r = mvr/qB$
45. Magnetic force between two wires which are having current in opposite direction will:  
 (a) Attract each other (b) Repel each other  
 (c) Experience no force between them (d) None of these
46. Magnetic flux is the dot product of magnetic induction and:  
 (a) Area (b) Vector area (c) Unit area (d) None of these
47. If a current wire of 2 A and length 5m enters perpendicular to magnetic field of 10T. Calculate the force experienced by it:  
 (a) 50 N (b) 100 N (c) 200 N (d) 25 N
48. A steady current passing through a conductor produces  
 (a) Electric field (b) Magnetic field (c) Both of these (d) None of these
49. Weber is the unit of .....  
 (a) Magnetic flux (b) Electric flux (c) Both a or b (d) None of these
50. Face of coil having clockwise current:  
 (a) Behaves like north pole (b) Behaves like south pole  
 (c) Becomes magnet of varying poles (d) Does not behaves like magnet

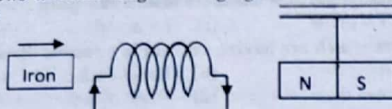
Sr.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	b	b	b	b	a	b

## PRACTICE TEST NO. 2

1. A circular loop of area  $0.05 \text{ m}^2$  rotates in a uniform magnetic field of  $0.2 \text{ T}$ . If the loop rotates about its diameter which is perpendicular to the magnetic field, find flux linked with loop when its plane is normal to the field:  
 (a)  $0.01 \text{ Wb}$  (b)  $0 \text{ Wb}$  (c)  $8.66 \times 10^{-3} \text{ Wb}$  (d)  $0.86 \text{ Wb}$
2. If a charge of  $2 \text{ C}$  is travelling parallel to a magnetic field of  $4 \text{ T}$  with  $20 \text{ m/s}$ . Calculate the net force on it.  
 (a)  $160 \text{ N}$  (b)  $120 \text{ N}$  (c)  $0 \text{ N}$  (d)  $100 \text{ N}$
3. A rectangular loop of dimension  $3 \text{ cm}$  by  $5 \text{ cm}$  is placed perpendicular in uniform magnetic field of  $0.1 \text{ T}$ , find the magnetic flux through the loop  
 (a)  $1.5 \text{ wb}$  (b)  $0.015 \text{ wb}$  (c)  $0.15 \text{ wb}$  (d)  $0.00015 \text{ Wb}$
4. If a proton, alpha particle and photon moving with same velocity enter in uniform magnetic field then which particle will deflect more  
 (a) Proton (b) Alpha particle (c) Photon (d) All of these
5. A charge is moving with velocity  $v$ , it enters a uniform magnetic field  $B$ . The direction  $v$  is perpendicular to  $B$ . What is the path of the charge particle inside the magnetic field?  
 (a) Parabolic (b) Circular (c) Parallel to  $v$  (d) Parallel to  $E$
6. If a charge of  $2 \text{ C}$  is moving with  $5 \text{ m/s}$  enter at  $30^\circ$  in  $3 \text{ T}$ , calculate the force experienced by it:  
 (a)  $10 \text{ N}$  (b)  $15 \text{ N}$  (c)  $20 \text{ N}$  (d)  $30 \text{ N}$
7. The unit of magnetic flux is:  
 (a) Tesla (b) Weber (c) Gauss (d) Henry
8. Ampere's law gives us the relationship between:  
 (a) Force and velocity of charge (b) Force and magnitude field  
 (c) Current and force (d) Current and magnetic field

Sr.	1.	2.	3.	4.	5.	6.	7.	8.
Ans:	b	c	d	b	b	b	b	d

9. The diagram shows a small magnet hanging on a thread near the end of a solenoid carrying steady current  $I$ ?

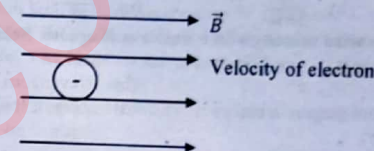


What happens to the magnet as the iron core is inserted into the solenoid?

- (a) It moves towards the solenoid  
(b) It moves away from the solenoid  
(c) It moves towards the solenoid and rotates through  $180^\circ$   
(d) It moves away from the solenoid and rotates through  $180^\circ$
10. For which value of " $\theta$ " between plane area of a coil and  $\vec{B}$ , flux reduces to  $\frac{\sqrt{3}}{2}$  times its maximum  
(a)  $30^\circ$  (b)  $90^\circ$  (c)  $45^\circ$  (d)  $60^\circ$
11. A proton is moving with velocity  $\vec{v}$  in a direction opposite to the direction of magnetic field  $\vec{B}$ . The magnetic force experienced by the proton is:  
(a)  $Bev$  (b)  $-Bev$  (c)  $Bv$  (d) Zero
12. The magnetic force on a current carrying conductor of length  $L$ , carrying total no. of charges " $nAL$ ", each charge of value " $q$ " is given as:  
(a)  $\vec{F} = q(\vec{v} \times \vec{B})$  (b)  $\vec{F} = qLA(\vec{v} \times \vec{B})$  (c)  $\vec{F} = qnAL(\vec{v} \times \vec{B})$  (d)  $\vec{F} = nAq(\vec{v} \times \vec{B})$
13. The magnetic flux is minimum when angle between magnetic field and plane area is:  
(a)  $0^\circ$  (b)  $30^\circ$  (c)  $60^\circ$  (d)  $90^\circ$
14. A particle moving in a magnetic field increase its velocity then its radius of the circle:  
(a) Decreases (b) Increases (c) Remains same (d) Becomes half
15. A proton, a deuteron and an  $\alpha$ -particle, having the same kinetic energy, are moving in circular trajectories in a constant magnetic field. If  $r_p$ ,  $r_d$  and  $r_\alpha$  denote, respectively the radii of the trajectories of these particles respectively, then:  
(a)  $r_\alpha = r_p < r_d$  (b)  $r_\alpha > r_d > r_p$  (c)  $r_\alpha = r_d > r_p$  (d)  $r_p = r_d < r_\alpha$
16. What happens to the magnetic field produce by a solenoid if the number of turns of solenoid and its current are doubled, while its length is quadrupled?  
(a) Becomes twice (b) Becomes quadrupled  
(c) Becomes 8 times (d) Remains same
17. In particle velocity selector method, the selected speed  $v$  is given by  
(a)  $v = \frac{E}{B}$  (b)  $v = \frac{E^2}{B}$  (c)  $v = \frac{B}{E}$  (d)  $v = \frac{E}{B^2}$
18. The force experienced by a charge particle is zero, when charge particle is projected at:  
(a)  $\theta = 0^\circ$  (b)  $\theta = 90^\circ$  (c)  $\theta = 45^\circ$  (d)  $\theta = 120^\circ$
19. A long straight current carrying conductor has current direction from bottom to top when held vertically. What will be the direction of magnetic field lines when observed from top of the conductor?  
(a) Clockwise (b) Vertically upward  
(c) Anticlockwise (d) Vertically downward
20. A proton and  $\alpha$ -particle enter a magnetic field normally. If the force experienced by the proton is double of that experienced by  $\alpha$ -particle, the ratio of their speeds is:  
(a) 0.5 (b) 2 (c) 1 (d) 4

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans:	b	d	d	c	a	b	b	d	a	a	c	b

21. Protons and  $\alpha$ -particles of equal momenta enter a uniform magnetic field normally. The radii of their orbits will have the ratio:  
(a) 1 (b) 2 (c) 0.5 (d) 4
22. One  $\text{Wb m}^{-2}$  is equal to:  
(a)  $10^4$  gauss (b)  $10^{-2}$  gauss (c)  $10^2$  gauss (d)  $10^{-2}$
23. A proton is moving with  $2 \times 10^7 \text{ ms}^{-1}$  parallel to a uniform magnetic field of 2.5 T. The magnetic force on the proton is:  
(a)  $2.5 \times 10^{-10} \text{ N}$  (b)  $8 \times 10^{-12} \text{ N}$  (c)  $8 \times 10^{-11} \text{ N}$  (d) Zero
24. If an electron is placed in a uniform magnetic field as shown in the figure. Then the direction of force acting on it is:



- (a) Upward (b) Downward (c) Out of the paper (d) None
25. A charge of 1C is moving in a magnetic field 0.5 T with a velocity of 10 m/s perpendicular to the field. Force experienced is:  
(a) 5 N (b) 10 N (c) 0.5 N (d) 0 N
26. A moving charge will gain energy due to the application of:  
(a) Electric field (b) Magnetic field (c) Both of these (d) None of these
27. An electron is moving in the north direction. It experiences a force in vertically upward direction. The magnetic field at the position of the electron is in the direction of:  
(a) East (b) West (c) North (d) South
28. A proton moving with velocity  $v$  is acted upon by electric field  $E$  and magnetic field  $B$ . the proton will move undeflected if:  
(a)  $E$  is perpendicular to  $B$  (b)  $E$  is parallel to  $v$  and perpendicular to  $B$   
(c)  $E$ ,  $B$  and  $v$  are mutually perpendicular and  $v = \frac{E}{B}$  (d)  $E$  and  $B$  both are parallel to  $v$
29. A strong magnetic field is applied on a stationary electron, then:  
(a) Electron moves in the direction of field (b) Electron moves in opposite direction  
(c) Electron remains stationary (d) Electron starts spinning
30. The current is flowing in south direction along a power line. The direction of magnetic field above the power line is:  
(a) South (b) East (c) North (d) West
31. A bar magnet is moved at a steady speed of  $2 \text{ ms}^{-1}$  towards a coil of wire which is connected to a galvanometer. The magnet is now withdrawn along the same path at 4 m/s. The deflection of the galvanometer is in the:  
(a) Same direction as previously, with the magnitude of deflection doubled  
(b) Opposite direction as previously, with the magnitude of deflection halved  
(c) Same direction as previously, with the magnitude of deflection halved  
(d) Opposite direction as previously, with the magnitude of deflection doubled

Sr.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
Ans:	b	a	d	d	A	a	a	c	c	d	a

32.  $F$  is maximum magnetic force acting on a charge. Now if we change the direction of velocity of charge and it makes an angle of  $45^\circ$  with magnetic field then the force becomes:
- (a)  $\frac{F}{2}$  (b)  $2F$  (c)  $\frac{F}{\sqrt{2}}$  (d)  $\sqrt{2}F$
33. An  $\alpha$ -particle and proton having same momentum enter into the region of uniform, perpendicular magnetic field. The ratio of radii of curvature of their circular paths in the magnetic field is:
- (a) 1:1 (b) 1:2 (c) 1:4 (d) 4:1
34. A charged particle of mass  $m$  and charge  $q$  describes circular motion of radius  $r$  in a uniform magnetic field of strength  $B$ . The frequency of revolution is:
- (a)  $\frac{Bq}{2\pi m}$  (b)  $\frac{Bq}{2\pi r m}$  (c)  $\frac{2\pi m}{Bq}$  (d)  $\frac{Bm}{2\pi q}$
35. A charged particle moves with velocity  $v$  in a uniform magnetic field  $B$ . The magnetic force experienced by the particle is:
- (a) Always zero (b) Never zero  
(c) Zero if  $B$  and  $V$  are perpendicular (d) Zero, if  $B$  and  $v$  are parallel
36. Magnetic flux is given by:
- (a) Dot product of magnetic field and area vector  
(b) Cross product of magnetic field and area vector  
(c) Both of these  
(d) None of these
37. Find the maximum force on the conductor having length 60cm, current 2.75 A and flux density of 9 units.
- (a) 14.8 (b) 18.45 (c) 84.25 (d) 7.325
38. When current passes through a solenoid coil, it behaves like a:
- (a) Circular magnet (b) Bar magnet  
(c) Loop magnet (d) Magnetic compass
39. When a magnet is moved with its N-pole towards a coil connected with galvanometer, the farther end of the coil acts as:
- (a) N-pole (b) S-pole (c) May A or B (d) None of these
40. An  $\alpha$ -particle moves at right angles to a uniform magnetic field of 1.0 T with a speed of  $10^7 \text{ ms}^{-1}$ . The force experienced by  $\alpha$ -particle is:
- (a)  $3.2 \times 10^{-12} \text{ N}$  (b)  $8 \times 10^{-13} \text{ N}$  (c)  $3.2 \times 10^{-11} \text{ N}$  (d)  $8 \times 10^{-11} \text{ N}$
41. An electron ( $\text{mass} = 9 \times 10^{-31} \text{ kg}$ ,  $\text{charge} = 1.6 \times 10^{-19} \text{ C}$ ) moving with a velocity of  $10^6 \text{ ms}^{-1}$  enters a region where magnetic field exists. If it describes a circle of radius 0.10 m, the magnetic field must be:
- (a)  $1.8 \times 10^{-4} \text{ T}$  (b)  $5.6 \times 10^{-5} \text{ T}$  (c)  $14.4 \times 10^{-5} \text{ T}$  (d)  $1.3 \times 10^{-6} \text{ T}$
42. An electron is moving horizontally towards East. If it enters in a magnetic field directed upward then the electron will be deflected in the direction of:
- (a) East (b) West (c) North (d) South
43. You are asked to design a solenoid that will give a magnetic field of 1.0 T, yet the current must not exceed 20A. The number of turns per unit length of that solenoid will be:
- (a)  $3.9 \times 10^4$  (b)  $9.1 \times 10^3$  (c)  $8.5 \times 10^3$  (d)  $1.25 \times 10^6$
44. Ions of different momenta ( $p$ ), having different charge, enter normally to a uniform magnetic field. The radius of the orbit of an ion is proportional to:
- (a)  $\frac{p}{q}$  (b)  $\frac{p^2}{q^2}$  (c)  $\frac{q}{p}$  (d)  $\frac{q^2}{p^2}$

Sr.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.
Ans:	c	b	a	d	a	a	b	b	a	b	c	a	a

45. The magnetic field along straight wire carrying a current  $I$  is proportional to:
- (a)  $I$  (b)  $I^3$  (c)  $\sqrt{I}$  (d)  $\frac{1}{I}$
46. If a proton is projected in a direction perpendicular to a uniform magnetic field with velocity  $v$  and an electron is projected along the lines of force, what will happen to proton and electron:
- (a) Electron will travel along a circle with constant speed and the proton will move along the straight line  
(b) Proton will move in a circle with constant speed and there will be no effect on the motion of electron  
(c) There will not be any effect on the motion of electron and proton  
(d) Electron and proton both will follow the path of a parabola
47. A proton enters a magnetic field of flux density  $1.5 \text{ weber m}^{-2}$  with a velocity of  $2 \times 10^7 \text{ m}^{-1}$  at an angle of  $30^\circ$  with the field. The force on the proton will be:
- (a)  $2.4 \times 10^{-12} \text{ N}$  (b)  $0.24 \times 10^{-12} \text{ N}$  (c)  $24 \times 10^{-12} \text{ N}$  (d)  $0.024 \times 10^{-12} \text{ N}$
48. A charge  $+Q$  is moving with upward velocity. It enters a magnetic field directed to the north. The force on the charge will be towards:
- (a) North (b) East (c) South (d) West
49. A charged particle is moving with velocity  $v$  in a magnetic field of induction  $B$ . The force on the particle will be maximum when:
- (a)  $v$  and  $B$  are in same direction (b)  $v$  and  $B$  are in opposite direction  
(c)  $v$  and  $B$  are perpendicular (d)  $v$  and  $B$  are at an angle of  $45^\circ$
50. When a magnetic field is applied in a direction perpendicular to the direction of cathode rays then their:
- (a) Energy decreases (b) Energy increases  
(c) Momentum increases (d) Magnitude of momentum and energy remains unchanged

Sr.	45.	46.	47.	48.	49.	50.
Ans:	a	b	a	d	c	d

## PRACTICE TEST NO. 3

1. A positively charged particle moving towards east enter a region of uniform magnetic field directed vertically upwards The particle will:
- (a) Get reflected vertically upward  
(b) Move in a circular orbit with its speed increased  
(c) Move in a circular orbit with its speed unchanged  
(d) Continue to move towards east
2. A proton moving with a velocity  $2.5 \times 10^7 \text{ m/s}$ , enters a magnetic field of intensity 2.5 T making an angle  $30^\circ$  with the magnetic field. The force on the proton is:
- (a)  $3 \times 10^{-12} \text{ N}$  (b)  $5 \times 10^{-12} \text{ N}$  (c)  $6 \times 10^{-12} \text{ N}$  (d)  $9 \times 10^{-12} \text{ N}$
3. An  $\alpha$ -particle and a proton travel with same velocity in a magnetic field perpendicular to the direction of their velocities, find the ratio of radii of their circular path:
- (a) 4:1 (b) 1:4 (c) 2:1 (d) 1:2
4. Charge to mass ratio of a particle depends upon:
- (a) Speed (b) Magnetic field (c) Radius (d) None of these

Sr.	1.	2.	3.	4.
Ans:	c	b	c	d

5. The value of  $e/m$  is smallest for:  
 (a) Proton (b) Electron (c)  $\beta$ -particle (d) Positron
6. Electron and proton of equal momentum enter a uniform magnetic field normal to the lines of force. If the radii of curvature of circular paths be  $r_e$  and  $r_p$  respectively then:  
 (a)  $\frac{r_e}{r_p} = 1$  (b)  $\frac{r_e}{r_p} = \frac{m_p}{m_e}$  (c)  $\frac{r_e}{r_p} = \sqrt{\frac{m_p}{m_e}}$  (d)  $\frac{r_e}{r_p} = \sqrt{\frac{m_e}{m_p}}$
7. Which of the following does not affect the motion of a moving electron?  
 (a) Electric field applied in the direction of motion  
 (b) Magnetic field applied in the direction of motion  
 (c) Electric field applied in the direction opposite of motion  
 (d) Magnetic field applied perpendicular to the direction of motion
8. A charged particle moving with a velocity  $\vec{v}$  enters a uniform magnetic field  $\vec{B}$ . The particle experiences the largest deflecting force when angle between velocity and magnetic field is:  
 (a)  $0^\circ$  (b)  $90^\circ$  (c)  $45^\circ$  (d)  $180^\circ$
9. A proton is moving in a circular orbit in a magnetic field with energy 1 MeV. The energy of an  $\alpha$ -particle which revolves in the same field in an orbit of the same radius is  
 (a) 0.5 MeV (b) 1 MeV (c) 2 MeV (d) 4 MeV
10. A charged particle enters a uniform magnetic field perpendicular to it. The magnetic field:  
 (a) Increases the kinetic energy of the particle  
 (b) Decreases the kinetic energy of the particle  
 (c) Changes the direction of motion of the particle  
 (d) Both a and c
11. A proton, an electron and an  $\alpha$ -particle accelerated through the same potential difference enter a region of uniform magnetic field, moving at right angle to the magnetic field. The ratio of their K.E is:  
 (a) 1:1:1 (b) 2:2:1 (c) 2:1:11 (d) 1:1:2
12. The magnetic effect of current was discovered by:  
 (a) Oersted (b) Faraday (c) Ampere (d) Ohm
13. The unit of  $\vec{E}$  is  $NC^{-1}$  and that of  $\vec{B}$  is  $NA^{-1}m^{-1}$ , then the unit of  $E/B$  is:  
 (a)  $ms^{-2}$  (b)  $ms^{-1}$  (c)  $ms$  (d)  $m^{-1}s^{-1}$
14. A charged particle enters in a strong magnetic field. Then its kinetic energy  
 (a) Increases  
 (b) Remains constant  
 (c) Decreases  
 (d) First increases and then becomes constant
15. Magnetism is related to \_\_\_\_\_:  
 (a) Stationary charges (b) Accelerated charges  
 (c) Moving charges (d) All of these
16. Electronic current is flowing through a straight conductor as shown in figure. The direction of magnetic lines of force when seen from below the conductor will be:



- (a) Clockwise (b) Anticlockwise (c) Top to bottom (d) Bottom to top
17. A positively charged particle projected towards west is deflected towards north by a magnetic field. The field must be:  
 (a) Towards west (b) Upward (c) Towards south (d) Downward

Sr.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Ans:	a	a	b	b	b	c	d	a	b	b	c	a	b

18. The force on a charge moving in a magnetic field is not independent of:  
 (a) Area of conductor (b) The momentum of the particle  
 (c) The intensity of the field (d) Both a and b
19. The value of permeability of free space is:  
 (a)  $10^{-7}\pi mA^{-1}$  (b)  $4\pi \times 10^{-7} T mA^{-1}$   
 (c)  $2\pi \times 10^{-7} T mA^{-1}$  (d)  $4\pi \times 10^7 T mA^{-1}$
20. Magnetic flux is maximum when angle is:  
 (a)  $0^\circ$  (b)  $90^\circ$  (c)  $120^\circ$  (d) All of these
21. Strength of magnetic field is called  
 (a) Strength (b) Flux (c) Magnetic flux density (d) Density
22. Magnetic field lines created by current carrying wire is  
 (a) Helical (b) Elliptical (c) Hyperbolic (d) Circular
23. Magnetic flux is scalar product of  
 (a)  $\vec{B}$  and  $\vec{V}$  (b)  $\vec{q}$  and  $\vec{A}$  (c)  $\vec{I}$  and  $\vec{l}$  (d) None of these
24. Magnetic field will not produce in case of  
 (a) Charged positive particles (b) Charged negative particles  
 (c) Neutral particles (d) All of these
25. Magnetic field along the axis of solenoid with  $n$  turns per unit length carrying current  $I$  is given by  
 (a)  $B = \mu_0 nI$  (b)  $B = \mu_0 N/L$  (c)  $B = \mu_0 NI$  (d)  $B = \mu_0 NIL$
26. Do magnetic flux lines intersect?  
 (a) Yes (b) No  
 (c) Depends on strength of field (d) Cannot be determined
27. Find the force due to a current element of length 2 cm and flux density of 12 tesla. The current through the element will be 5A.  
 (a) 1N (b) 1.2N (c) 1.4N (d) 1.6N
28. Magnetic flux is zero:  
 (a) When angle is  $90^\circ$  (b) Angle is  $0^\circ$   
 (c) Angle is  $180^\circ$  (d) None of these
29. A square loop of side 2 m is placed in a 5T of magnetic field. What will be the related flux?  
 (a) 2.5 Weber (b) 5 Weber (c) 10 Weber (d) 20 Weber
30. Find the Lorentz force of a charge 2.5C having an electric field of 5 units and magnetic field of 7.25 units with a velocity 1.5m/s:  
 (a) 39.68 (b) 68.93 (c) 89.39 (d) 63.98
31. Force acting on a negative charge is always  
 (a) In the direction opposite to electric field  
 (b) In the direction of electric field  
 (c) In the direction perpendicular to electric field  
 (d) In the direction perpendicular to the velocity of charge
32. Unit of relative permeability is  
 (a) Henry (b) Henry/m  
 (c) Dimensionless (d) Henry/sq.m
33. Work done by the magnetic force on charged particle in presence of perpendicular magnetic field is  
 (a) Positive (b) Zero (c) Negative (d) None of these

Sr.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
Ans:	c	b	a	c	d	d	c	a	b	b	a	d	a	a	c	b

34. A charged particle is moving on circular path with velocity  $v$  in a uniform magnetic field  $B$ , if the velocity of the charged particle is doubled and strength of magnetic field is halved, then radius becomes:

- (a) 8 times (b) 2 times (c) 4 times (d) 16 times

35. What happens to the flux if applied magnetic field is doubled on the same surface?

- (a) Become half (b) Becomes twice  
(c) Becomes infinite (d) Becomes 4 times

36. Force experienced by charge particles in magnetic field is

- (a) Perpendicular to velocity (b) Perpendicular to field  
(c) Parallel to field (d) Perpendicular to velocity and field

37. Do magnetic flux lines intersect?

- (a) Yes (b) No  
(c) Depends on strength of field (d) Cannot be determined

38. Two  $\alpha$ -particles have the ratio of their velocities as 3 : 2 on entering the field. If they move in different circular paths, then the ratio of the radii of their paths is

- (a) 2 : 3 (b) 3 : 2 (c) 4 : 9 (d) 9 : 4

39. If the direction of the field and area vector is opposite then flux is:

- (a) Positive (b) Zero (c) Negative (d) None of these

40. A 3 cm wire carrying a current of 10A is placed a long along axis inside a solenoid of magnetic field 0.35 T. The net force felt by wire is:

- (a) 11.5 N (b) 0.105 N (c) 9.5 N (d) Zero

41. Consider a charge  $q$  is placed in a region where both electric and magnetic fields are present. The charge will experience:

- (a) Both electric and magnetic forces (b) Only electric force  
(c) Only magnetic force (d) No force at all

42. If magnetic field vector is  $B = (i + 5j + 2k)$  and area vector is  $(6i - 2j + 2k)$  then flux related to this is

- (a) 10 Wb (b) 15 Wb (c) 20 Wb (d) 0 Wb

43. Current and induced magnetic field are always:

- (a) Perpendicular (b) Parallel (c) Circular (d) None of these

44. A solenoid bent into a circle is called:

- (a) Resistor (b) Capacitor (c) Inductor (d) Toroid

45. Force on a moving charge in a uniform magnetic field will be maximum, when angle between  $v$  and  $B$  is

- (a) 0 (b) 30 (c) 60 (d) 90

46. Magnetic flux is \_\_\_\_\_ product.

- (a) Scalar (b) Vector (c) Simple (d) None of these

47. 1 tesla is equal to:

- (a) 100 N/Am (b) 1 N/Am (c) 0.1 Nm/A (d) 1 Nm/A

48. If velocity of charged particle and magnetic field are at a fix angle not 90 then path will be

- (a) Circular (b) Straight line (c) Spherical (d) Helical

49. Due to difference in a straight conductor the difference between magnetic field lines:

- (a) Increases away from conductor (b) Decreases away from conductor  
(c) Increases towards conductor (d) Decreases and then increases towards conductor

50. Magnetic field strength is measure in:

- (a)  $Wb m^{-1}$  (b)  $Wb m^{-2}$  (c)  $Wb m^2$  (d) Wb

## PRACTICE TEST NO.4

1. A proton moving with a constant velocity passes through a region of space without any change in its velocity. If  $E$  and  $B$  represent the electric and magnetic fields respectively, then this region of space may have:

- (a)  $E = 0, B = 0$  (b)  $E = 0, B \neq 0$  (c)  $E \neq 0, B = 0$  (d)  $E \neq 0, B \neq 0$

2. An electron is travelling horizontally towards east. A magnetic field is vertically downward direction exerts a force on the electron along:

- (a) East (b) West (c) North (d) South

3. A proton and an electron both moving with the same velocity  $v$  enter into a region of magnetic field directed perpendicular to the velocity of the particles. They will now in circular orbits such that:

- (a) Their time period will be same (b) Time period of proton will be higher  
(c) Time period for electron will be higher (d) Their orbital radii will be same

4. An electron enters a magnetic field whose direction is perpendicular to the velocity of the electron then,

- (a) Speed of electron will increase (b) Speed of electron will be decrease  
(c) Speed of electron will remain same (d) Velocity of electron will remain the same

5. An electron and a proton enter a magnetic field perpendicularly. Both have same K.E. Which of the following is true:

- (a) Trajectory of electron is less curved  
(b) Trajectory of proton is less curved  
(c) Both trajectories are equal curved  
(d) Both move on straight line path

6. A charge moves in a circle perpendicular to a magnetic field. The time period of revolution is independent of:

- (a) Magnetic field (b) Charge (c) Mass of the particle (d) Velocity of the particle

7. If an electron is going in the direction of magnetic field  $B$  with the velocity of  $v$  then the force on electron is:

- (a) Zero (b)  $e(v \cdot B)$  (c)  $e(v \times B)$  (d) None of these

8. An electron is travelling in east direction and a magnetic field is applied in upward direction then electron will deflect in:

- (a) South (b) North (c) West (d) East

9. If cathode rays are projected at right angles to a magnetic field their trajectory is:

- (a) Ellipse (b) Circle (c) Parabola (d) None of these

10. The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to the:

- (a) Charge of the particle (b) Momentum of the particle  
(c) Energy of the particle (d) Strength of the field

11. A charged particle enters a magnetic field such that the direction of initial velocity is different from the direction of the field. Which (one or more) of the following characteristics of the particle is same with time?

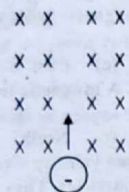
- (a) Momentum (b) Kinetic energy  
(c) Acceleration (d) Direction of motion

12. The value of permeability of free space is:

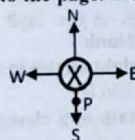
- (a)  $10^{-7} Tm A^{-1}$  (b)  $4\pi \times 10^{-7} Tm A^{-1}$  (c)  $2\pi \times 10^{-7} Tm A^{-1}$  (d)  $4\pi \times 10^7 Tm A^{-1}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Ans:	d	c	b	c	b	d	a	b	b	b	b	b

13. A negative charge moving with constant velocity  $v$  enters a region of uniform magnetic field pointing into the page. What is the direction of the magnetic force on the charge?



- (a) Left wards (b) Right wards (c) To the bottom of page (d) To the top of page
14. An electron is injected into a uniform magnetic field with components of velocity parallel to and normal to the field direction. The path of the electron is a:
- (a) Helix (b) Circle (c) Parabola (d) Straight line
15. The unit of magnetic flux is
- (a) Weber (b)  $\text{Wb m}^{-3}$  (c) Henry (d)  $\text{A m}^{-1}$
16. The magnetic field inside a solenoid is:
- (a) Zero (b) Non-uniform (c) Infinite (d) Uniform
17. An electron enters the magnetic field from right towards left,  $B$  is into paper. The electron will be deflected:
- (a) Upward (b) Downward (c) Toward (d) None of these
18. Magnetic flux, mathematically is defined as:
- (a)  $\phi = \vec{B} \cdot \vec{A}$  (b)  $\phi = \vec{E} \cdot \vec{A}$  (c)  $\phi = \vec{B} \times \vec{A}$  (d)  $\phi = \vec{E} \times \vec{A}$
19. The  $e/m$  of an electron moving in a circular path in a magnetic field in terms of velocity  $v$  radius  $r$  and magnetic field  $B$  is given by:
- (a)  $\frac{v}{Br}$  (b)  $\frac{v}{B^2 r}$  (c)  $\frac{v^2}{Br}$  (d)  $\frac{v}{Br^2}$
20. A vertical wire carries an electronic current into the page. What is the direction of magnetic field at point P located as shown?



- (a) West (b) East (c) North (d) South
21. A magnetic field:
- (a) Always exerts a force on a charged particle
- (b) Never exerts a force on a charged particle
- (c) Exerts a force, if the charged particle is moving across the magnetic field lines
- (d) Exerts a force, if the charged particle is moving along the magnetic field lines
22. \_\_\_\_\_ is correct relation ( $T = \text{tesla}$  and  $G = \text{gauss}$ ):
- (a)  $1 T = 10^4 G$  (b)  $1 T = 10^{-2} G$  (c)  $1 T = 10^{-4} G$  (d)  $1 T = 10^2 G$
23. While finding the radius of circular path in the experiment to find  $e/m$  of electron, the glass tube is filled with:
- (a)  $\text{H}_2$  (b) He (c)  $\text{O}_2$  (d)  $\text{CO}_2$

Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Ans:	b	a	a	d	a	a	a	b	c	a	a

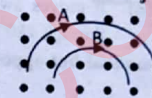
24. The magnetic field due to a current-carrying solenoid which has 'n' number of turns per unit length is:

(a)  $B = \mu_0 n I$  (b)  $B = \mu_0 n^2 I$  (c)  $B = \frac{\mu_0 n I}{l}$  (d)  $B = \frac{\mu_0 n^2 I}{l}$

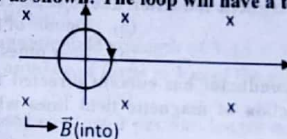
25. A very long solenoid has 400 turns per meter length of the solenoid. A current of 1.6 A flows through it. Then the magnetic induction at the middle point of the solenoid on its axis, is approximately:

(a)  $16 \times 10^{-4} \text{ T}$  (b)  $32 \times 10^{-4} \text{ T}$  (c)  $8 \times 10^{-4} \text{ T}$  (d)  $4 \times 10^{-4} \text{ T}$

26. Two particles A and B of mass  $m_A$  and  $m_B$  respectively and having the same charges are moving in a plane. A uniform magnetic field exists perpendicular to this plane. The speed of the particles are  $v_A$  and  $v_B$  respectively and the trajectories are shown in the figure. Then:



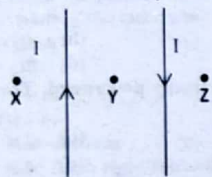
- (a)  $m_A v_A < m_B v_B$  (b)  $m_A v_A > m_B v_B$
- (c)  $m_B > v_A$  and  $v_A = v_B$  (d)  $m_A = m_B$  and  $v_A = v_B$
27. A cable carries a current of 2 A vertically downward. The magnetic field produced by it at a point 10 cm north will be:
- (a)  $2 \times 10^{-6}$  tesla west (b)  $2 \times 10^{-6}$  tesla east
- (c)  $4 \times 10^{-6}$  tesla west (d)  $4 \times 10^{-6}$  tesla east
28. What is the magnetic force on a stationary charged particle in a uniform magnetic field?
- (a) Zero (b)  $F = qvB$  (c)  $F = q(v \times B)$  (d)  $F = ILB \sin \theta$
29. A current is flowing towards North along a power line. The direction of magnetic field above it, neglecting the earth's field, is:
- (a) North (b) South (c) East (d) West
30. A conducting loop carrying electronic current  $I$  is placed in a uniform magnetic field pointing into plane of the paper as shown. The loop will have a tendency to:



- (a) Contract (b) Expand (c) Move towards x-axis (d) Move towards y-axis
31. Magnetic flux density is defined in terms of:
- (a) Tesla (b)  $\text{Wb m}^{-2}$  (c)  $\text{N m}^{-1} \text{A}^{-1}$  (d) All of these
32. The imaginary closed path around a current conductor at which magnetic induction is to be determined is called:
- (a) Amperian path (b) Amperian surface
- (c) Gaussian surface (d) Lorentz path
33. During the circular path in magnetic field, what is the magnetic force
- (a)  $F = Qb$  (b)  $F = qB^2$  (c)  $F = qB/v$  (d)  $F = qvB$
34. The magnetic field is parallel to a surface, then the magnetic flux through the surface is:
- (a) Zero (b) Small but not zero (c) Infinite (d) Larger than I

Sr.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Ans:	a	c	c	c	a	c	a	d	a	d	a

35. 'F' is maximum force acting on a conductor. Now if we change the direction of conductor by making an angle of  $45^\circ$  with the magnetic field then the force becomes:  
 (a)  $\frac{F}{2}$  (b)  $\frac{F}{\sqrt{2}}$  (c)  $2F$  (d)  $\sqrt{2}F$
36. If we doubled all the parameters of the force acting on current carrying conductor and  $\theta = 90^\circ$  then magnetic force becomes:  
 (a) Double (b) Four times (c) 8 times (d) 16 times
37. What happens to the magnet as the iron core is inserted into the solenoid?  
 (a) It moves towards solenoid and rotates through  $180^\circ$  (b) It moves towards the solenoid through  $180^\circ$   
 (c) It moves away from solenoid (d) It moves away from solenoid and rotates through  $180^\circ$
38. Two long straight parallel wires held vertically have equal but opposite currents as shown in the figure.



Which of the following effect will be observed?

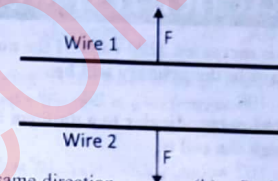
- (a) Magnetic field at 'X' is stronger than that at 'Y' and 'Z'  
 (b) Magnetic field at 'Y' is weaker than that at 'X' and 'Z'  
 (c) Magnetic field at 'X', 'Y' and 'Z' is same  
 (d) Magnetic field at 'X' is weaker than that at 'Y' but stronger than that at 'Z'
39. A solenoid is cut into two halves. Magnetic induction due to same current in each half will be:  
 (a) Half of the original (b) Double of the original  
 (c) Same as original (d) Four times of the original
40. A long straight current carrying conductor has current directed from bottom to top when held vertically. What will be the direction of magnetic field lines when observed from below the conductor?  
 (a) Clockwise (b) Anti clockwise  
 (c) Vertically upward (d) Vertically downward
41. The diagram shows a wire, carrying a current 'I', placed between the poles of magnet: In which direction does the force on the wire act?



- (a) Towards the 'N' pole of the magnet (b) Downwards  
 (c) Upwards (d) Towards the 'S' pole of the magnet

Sr.	35.	36.	37.	38.	39.	40.	41.
Ans:	b	c	a	b	c	a	b

42. If the number of turns of a solenoid circular coil is doubled, but the current in the coil and radius of the coil remains same, then what will be the magnetic flux density produced by the coil?  
 (a) Magnetic flux density will be halved  
 (b) Magnetic flux density increases by different amount at different points  
 (c) Magnetic flux density remains unchanged  
 (d) Magnetic flux density will be doubled
43. Two long parallel wires Wire 1 and Wire 2 repel each other as shown in the figure. What could be the reasons?



- (a) Both carry current in same direction (b) Both carry current in opposite direction  
 (c) Wire 1 has current, but Wire 2 has no current (d) Wire 2 has current, Wire 1 has no current
44. A 10 cm long solenoid has 100 turns. What will be the magnetic field inside it along its axis if one micro ampere current is passed through it?  
 (a)  $4\pi \times 10^{-13}$  telsa (b)  $4\pi \times 10^{-7}$  telsa (c)  $4\pi \times 10^{-10}$  telsa (d)  $4\pi \times 10^{-16}$  telsa
45. Two  $\alpha$ -particles have the ratio of their velocities as 3 : 2 on entering the magnetic field. If they move in different circular paths, then the ratio of the radii of their paths is  
 (a) 2 : 3 (b) 3 : 2 (c) 4 : 9 (d) 9 : 4
46. A solenoid 15.0 cm long has 300 turns of wire, a current 5 A flows through it. The magnitude of magnetic field inside the solenoid is:  
 (a)  $1.256 \times 10^{-7} \text{ Wbm}^{-2}$  (b)  $1.256 \times 10^{-5} \text{ Wbm}^{-2}$   
 (c)  $1.256 \times 10^{-2} \text{ Wbm}^{-2}$  (d)  $1.256 \times 10^{-7} \text{ Wbm}^{-2}$
47. A long solenoid has magnetic field strength of  $3.14 \times 10^{-2} \text{ T}$  inside it when a current of 5 A passes through it. The number of turns in 1 m of the solenoid is:  
 (a) 1000 (b) 5000 (c) 3000 (d) 10000
48. Force on current carrying conductor per unit length is given by:  
 (a)  $IL \sin \theta$  (b)  $ILB$  (c)  $IL$  (d)  $IB \sin \theta$
49. If a charge  $q$  is moving in a velocity selector. The charge will move in a straight path if :  
 (a)  $v = \frac{E}{B}$  (b)  $E$  is perpendicular to  $B$ . (c)  $F_m = F_e$  (d) All of these
50. A charge particle is moving in a circular path in a perpendicular magnetic field. By increasing the magnetic field charge to mass ratio of the particle will:  
 (a) Increase (b) Decrease (c) Remain same (d) None

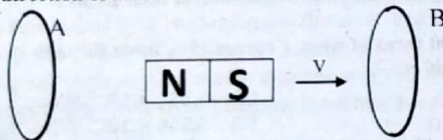
Sr.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	d	c	b	c	b	a	d	c

## UNIT 09 &gt;&gt;

ELECTROMAGNETIC  
INDUCTION

## PRACTICE TEST NO. 1

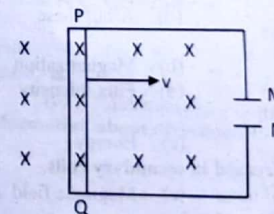
- In a transformer 220 ac voltage is increased 2200 volts. If the number of turns in the secondary are 2000, then the number of turns in the primary will be:  
(a) 200 (b) 100 (c) 50 (d) 20
- A square coil  $10^{-2} \text{ m}^2$  area is placed perpendicular to a uniform magnetic field of intensity  $10^3 \text{ Wbm}^{-2}$ . The magnetic flux through the coil is:  
(a) 10 weber (b)  $10^{-5}$  weber (c)  $10^5$  weber (d) 100 weber
- A coil having an area  $2 \text{ m}^2$  is placed in a magnetic field which changes from  $1 \text{ Wbm}^{-2}$  to  $4 \text{ Wbm}^{-2}$  in a interval of 2 s. The emf induced in the coil will be:  
(a) 4V (b) 3V (c) 1.5 V (d) 2 V
- To induce an emf in a coil, the linking magnetic flux:  
(a) Must decrease (b) Can either increase or decrease  
(c) Remain constant (d) Increase
- In the diagram shown if a bar magnet is moved along the common axis of two single turn coil A and B in the direction of arrow then:



- Current is induced only in A and in B (b) Induced currents in A & B are in same direction  
(c) Current is induced only in A and not in B (d) Induced currents in A & B are in opposite directions
- An aeroplane in which the distance between the tips of wings is 50 m is flying horizontally with a speed of  $360 \text{ kmh}^{-1}$  over a place where the vertical components of earth magnetic field is  $2 \times 10^{-4} \text{ Wbm}^{-2}$ . The potential difference between the tips of wings would be:  
(a) 0.1 V (b) 1.0 V (c) 0.2 V (d) 0.01 V
- A coil of N turns and mean cross-sectional area A is rotating with uniform angular velocity  $\omega$  about an axis at right angle to uniform magnetic field B. Then the emf developed between the centre and the rim of the plate is:  
(a)  $NBA \sin \omega t$  (b)  $NB \omega \sin \omega t$  (c)  $\frac{NB}{A} \sin \omega t$  (d)  $NBA \omega \sin \omega t$
- The core of a transformer is assembled with laminated plates to reduce energy losses due to:  
(a) Eddy current (b) Hysteresis (c) Resistance in winding (d) None of these
- What is increased in step-down transformer?  
(a) Voltage (b) Current (c) Power (d) Current density

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Ans:	a	a	b	b	d	b	d	a	b

- The ratio of secondary to the primary turns in a transformer is 3:2. If the power output be P, then the input power neglecting all losses will be equal to:  
(a) 5P (b) 1.5 P (c) P (d)  $\frac{2}{5} P$
- A 100% efficient transformer has 100 turns in the primary and 25 turns in its secondary coil. If the current in the secondary coil is 4 amp, then the current in the primary coil is:  
(a) 1 amp (b) 4 amp (c) 8 amp (d) 16 amp
- A transformer is used to:  
(a) Change the alternating potential (b) Change the alternating current  
(c) Prevent the power loss in alternating current flow (d) All of these
- The induced emf in a coil having 'N' number of loops is equal to N times the negative of the rate of change of magnetic flux linked with coil, is a statement of:  
(a) Lenz's law (b) Ohm's law  
(c) Faraday's law (d) Coulomb's law
- Maximum motional emf in a conductor is given as:  
(a)  $\varepsilon = -vBL \sin \theta$  (b)  $\varepsilon = -v^2 BL$   
(c)  $\varepsilon = -vBL \cos \theta$  (d)  $\varepsilon = -vBL$
- Carbon brushes in A.C generator are:  
(a) Moving (b) Stationary  
(c) Sometimes moving & sometimes stationary (d) Moving with increasing speed
- In A.C generator if plane of coil is parallel to magnetic field, the emf induced is:  
(a)  $\varepsilon = N\omega A$  (b)  $\varepsilon = \text{Zero}$  (c)  $\varepsilon = N\omega AB$  (d)  $\varepsilon = NfAB \sin \theta$
- The angular frequency of armature coil is \_\_\_\_\_ if A.C generator produces current of 50 Hz frequency:  
(a)  $50 \pi$  (b)  $200 \pi$  (c)  $100 \pi$  (d)  $25 \pi$
- A wire loop is rotated in a uniform magnetic field about an axis perpendicular to the field. The direction of the current induced in the loop reverses once each:  
(a) Quarter revolution (b) Full revolution  
(c) Half revolution (d) Two revolution
- A rod PQ is connected to the capacitor plates. The rod is placed in a magnetic field (B). If the rod is pulled out of magnetic field with velocity  $\vec{v}$  as shown:



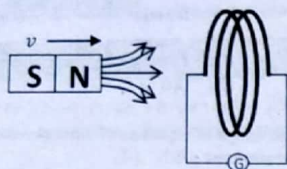
- Plate M will be negatively charged (b) Both plates will be similarly charged  
(c) Plate N will be negatively charged (d) No charge will be collected on plates
- A rectangular coil of 100 turns and size  $0.1 \text{ m} \times 0.05 \text{ m}$  is placed perpendicular to a magnetic field of 0.1 T. The induced emf when the field drops to 0.05 T in 0.05 s is:  
(a) 0.5 V (b) 0.25 V (c) 1.0 V (d) 2.0 V

Sr.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans:	c	a	a	c	d	b	c	c	b	c	a

21. In a circuit, the induced emf increase if:

- (a) The flux linked is more (b) There is no change in the flux  
(c) The rate of change of flux is increases (d) None of these

22. A magnet is placed along the axis of circular coil. The magnet is moved towards the coil. The induced current in coil (as viewed from left side of circular coil is) is:



- (a) Zero (b) Clockwise  
(c) Anticlockwise (d) Can't be predicted

23. The mechanical energy spent by the external agency on a metallic rod connected with galvanometer and moving perpendicular to a magnetic field is converted into electrical energy. To increase electrical energy, mechanical energy has to be increased. This relates to:

- (a) Ohm's law (b) Coulomb's law  
(c) Lenz's law (d) Newton's law of motion

24. A device which converts mechanical energy into electrical energy is called:

- (a) Current generator (b) The same and to the right  
(c) Transformer (d) Inverter

25. By which of the following way an emf can be induced in a circuit that represent in an external magnetic field?

- (a) By changing the area of circuit coil (b) By changing the magnetic field strength  
(c) By motion of the circuit coil (d) All of these

26. A conducting rod of length 0.5 m moves parallel to a magnetic field of magnitude 2 T with velocity  $5 \text{ ms}^{-1}$ , the emf induced in the moving rod is:

- (a) 5 V (b) 10 V (c) 20 V (d) 0 V

27. In A.C generator \_\_\_\_\_ are responsible to provide induced current from armature to external circuit:

- (a) Carbon brushes (b) Split rings (c) Magnet (d) Load

28. The Lenz's law refers to:

- (a) Induced current (b) Induced potential  
(c) Motional emf (d) All of these

29. Magnetic induction is also called

- (a) Flux (b) Magnetization  
(c) Magnetic intensity (d) Flux intensity

30. The role of inductance is equivalent to

- (a) Inertia (b) Force (c) Energy (d) Momentum

31. In step down transformer \_\_\_\_\_ is decreased in secondary coils.

- (a) Electric field (b) Number of turns (c) Magnetic field (d) None of these

32. Motional emf induced in a coil is independent of

- (a) Number of turns (b) Change in flux  
(c) Change in time (d) Resistance

33. For a metal rod of length L and moving with speed v in perpendicular to magnetic field then motional emf at its end is

- (a)  $vBL$  (b)  $vBL^2$  (c)  $v^2BL$  (d) None of these

Sr.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
Ans:	c	c	c	a	d	d	b	a	d	a	b	d	a

34. One of the major reasons for power loss in transformer is

- (a) Radiation loss (b) Convection loss  
(c) Eddy current loss (d) All of these

35. Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This is called

- (a) Electromagnetic induction (b) Kirchoff's law  
(c) Hysteresis loss (d) Lenz's law

36. Time varying magnetic field creates electric field, this is called

- (a) Electric induction (b) Magnetic induction  
(c) Electromagnetic induction (d) Dipole induction

37. The direction of induced current is always so as to oppose the change which causes the current is

- (a) Faraday's law (b) Lenz's law (c) Ohm's law (d) Kirchoff's law

38. Transformer operates on:

- (a) A.C (b) D.C (c) Both (d) None of these

39. Current carrying loop behave like a magnetic:

- (a) Monopole (b) Dipole (c) Quadrupole (d) Octopole

40. Faraday law states that the rate of change of magnetic flux is equal to:

- (a) Electromotive force (b) Induced current  
(c) Induced flux (d) Induced magnetic field

41. Power transformers are designed to have maximum efficiency at:

- (a) Full load (b) 50 % (c) 80 % (d) No load

42. Which of the following is expression of induced current in A.C generator?

- (a)  $I = \frac{\epsilon_0}{R} \sin(\omega t)$  (b)  $I = \frac{\epsilon_0}{R} \cos(\omega t)$  (c)  $I = \frac{\epsilon_0}{R} \tan(\omega t)$  (d)  $I = \frac{\epsilon_0}{R} \sec(\omega t)$

43. "The direction of the induced current is always so as to oppose the change which causes" is a statement of:

- (a) Faraday's law (b) Lenz's law (c) Ampere's law (d) Ohm's law

44. A straight conductor of length 4 m moves at a speed of  $5 \text{ m s}^{-1}$  when the conductor moves at an angle of  $60^\circ$  with the direction of magnetic field of induction 0.5 T, the emf induced is:

- (a) 7.07 V (b) 8.66 V (c) 6.75 V (d) 5.0 V

45. In A.C generator, if coil rotates with frequency of 50 Hz, how many times the current will reverse its direction in one second:

- (a) 100 (b) 50 (c) 200 (d) 25

46. The working principle of an A.C. Generator is:

- (a) Self induction (b) Ohm's law  
(c) Mutual induction (d) Faraday's law

47. Emf produced in generator is:

- (a)  $N\omega A b \cos(\omega t)$  (b)  $N\omega A b \tan(\omega t)$  (c)  $N\omega A b \cot(\omega t)$  (d)  $N\omega A b \sin(\omega t)$

48. Lenz's law provides information about direction of:

- (a) Inductance (b) Induced current  
(c) Induced flux (d) Induced magnetic field

49. SI unit of inductance is

- (a) Henry (b) Farad (c) Maxwell (d) Weber

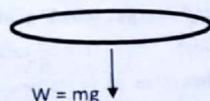
50. When north pole of bar magnet move towards a conducting loop, induced current flows in

- (a) Clockwise direction (b) Anticlockwise direction  
(c) Not generates (d) Not enough information

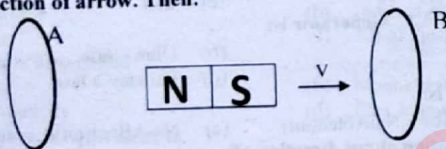
Sr.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	a	c	b	a	b	a	a	a	b	b	b	d	d	b	a	d

## PRACTICE TEST NO. 2

- SI unit of magnetic induction is  
(a) Weber (b) Gauss (c) Tesla (d) Maxwell
- The insulation between sheets of transformer core is to get small:  
(a) Hysteresis loop (b) Eddy current (c) Both (d) None of these
- Power transformer have maximum efficiency at  
(a) No load (b) Full load (c) Half load (d) Double load
- Calculate the maximum motional emf when the velocity is 10m/s, the length is 3m and the magnetic field density is 5T  
(a) 150V (b) 300V (c) 100V (d) 0V
- A real transformer does not change:  
(a) Voltage level (b) Power level (c) Current level (d) Frequency level
- Principle of transformer is  
(a) Mutual induction (b) Self induction (c) Motional emf (d) All of these
- Motional emf induced in a coil is dependent on  
(a) Magnetic field (b) Orientation (c) Length (d) All of these
- A ring is allowed to fall above a magnet as shown in the following figure:




- Clock-wise, south
  - Clock-wise, north
  - Anti-clockwise, north
  - Anticlockwise, south
9. In the diagram shown a bar magnet is moved along the common axis of two single turn coils A and B in the direction of arrow. Then:



- Current is induced only in A and not in B
  - Induced currents in A & B are in the same direction
  - Current is induced only in B and not in A
  - Induced current in A and B are in opposite directions
10. The magnitude of induced emf is proportional to:  
(a) Increase in flux (b) Decrease in flux  
(c) Rate of change of flux (d) Change in flux
11. Faraday's law explains how electric field will interact with  
(a) Electric field (b) Magnetic field (c) Battery (d) None of these

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Ans:	c	b	b	a	d	a	d	c	d	c	b

- The motional emf is given by  
(a)  $qvB$  (b)  $iBL$  (c)  $eBL$  (d)  $vBL$
  - When the coil and a bar magnet are placed very close to each other, then the value of their induced e.m.f will be:  
(a) Maximum (b) Positive (c) Negative (d) Zero
  - A bar magnet is hung by a string with North pole faced downward starts oscillating above a horizontal circular coil. Which of the following statement about the induced current is true (viewed from above).  
(a) Induced current flows clock wise  
(b) Induced current flows anticlockwise  
(c) Induced current reverses its direction repeatedly  
(d) None of these
- 
- The magnetic flux linked with a coil is changed from 1 Wb to 0.1 Wb in 0.01 s. The induced emf is:  
(a) 9 V (b) 0.009 V  
(c) 10 V (d) 90 V
  - An alternating voltage produced by ac generator is given by  $20\sin(157t)$ . The frequency of alternating voltage is:  
(a) 50 Hz (b) 100 Hz (c) 25 Hz (d) 75 Hz
  - A coil of 20cm  $\times$  20cm having 30 turns is making 30 rps in a magnetic field of 1 T. The peak value of the induced emf is approximately:  
(a) 452 V (b) 113 V (c) 226 V (d) 339 V
  - Two different wire loops are concentric and lie in the same plane. The current in the outer loop is clockwise and increasing with time. The induced current in the inner loop then is:  
(a) Clock wise  
(b) Counter clock wise  
(c) Zero  
(d) In a direction that depends on the ratio of the loop radii
  - Which of the following is not statement of Faraday's proposed laws of electromagnetic induction?  
(a) Changing magnetic field induces an electromagnetic force in conductor  
(b) Electromagnetic force is proportional to rate of change of field  
(c) Induced current opposes the cause which induces it  
(d) Both A and B
  - In A.C generator if vector area of coil is parallel to magnetic field, the emf induced is:  
(a) Half of maximum (b) Zero  
(c) Maximum (d) One fourth of maximum
  - Slip rings in A.C generator are connected with:  
(a) Ends of armature coil (b) Field magnet  
(c) External load resistance (d) Commutator
  - A device which converts mechanical energy into electrical energy called:  
(a) Current generator (b) Electric motor  
(c) Thermistor (d) Transformer
  - In a primary coil 5 A current is flowing on 220 volts. In the secondary coil 2200 V voltage produces. Then ratio of number of turns in secondary coil and primary coil will be:  
(a) 1:10 (b) 10:1 (c) 1:1 (d) 11:1

Sr.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Ans:	d	d	c	d	c	c	b	d	c	a	a	b

24. The alternating voltage induced in the secondary coil of a transformer is mainly due to:  
 (a) Varying electric field (b) Varying magnetic field  
 (c) Vibrations of the primary coil (d) Iron core of transformer
25. The magnetic flux through a circuit of resistance  $R$  changes by an amount  $\Delta\Phi$  in time  $\Delta t$ . Then the total electric charge  $Q$ , which passing during this time through any point of circuit is given by:  
 (a)  $Q = \frac{\Delta\Phi}{\Delta t} + \Delta t$  (b)  $Q = \frac{\Delta\Phi}{\Delta t} \times R \times t$  (c)  $Q = -\frac{\Delta\Phi}{\Delta t} + R \times t$  (d)  $Q = \frac{\Delta\Phi}{R} \times t$
26. A device converts electrical energy into mechanical energy is:  
 (a) Dynamo (b) Generator (c) Electric motor (d) Induction coil
27. A transformer is based on the principle of:  
 (a) Mutual induction (b) Self induction  
 (c) Ampere's law (d) Lenz's law
28. A two meter wire is moving with a velocity of  $1\text{ms}^{-1}$  perpendicular to a magnetic field of  $0.5\text{Wbm}^{-1}$ . The emf induced in it will be:  
 (a) 0.5 volt (b) 0.1 volt (c) 1 volt (d) 2 volt
29. When a wire loop is rotated in a magnetic field, the direction of induced emf changes once in each:  
 (a)  $\frac{1}{4}$  revolution (b)  $\frac{1}{2}$  revolution (c) 1 revolution (d) 2 revolution
30. A moving conductor coil in a magnetic field produces an induced emf. This is in accordance with:  
 (a) Ampere law (b) Coulomb law (c) Lenz's law (d) Faraday's law
31. A coil of 100 turns and area 5 square centimeter is placed in a magnetic field  $B = 0.2\text{ T}$ . The normal to the plane of the coil makes an angle of  $60^\circ$  with the direction of the magnetic field. The magnetic flux linked with the coil is:  
 (a)  $5 \times 10^{-3}\text{ Wb}$  (b)  $5 \times 10^{-5}\text{ Wb}$  (c)  $10^{-2}\text{ Wb}$  (d)  $10^{-4}\text{ Wb}$
32. A coil of area  $100\text{cm}^2$  has 500 turns. Magnetic field of  $0.1\text{Wbm}^{-2}$  is perpendicular to the coil. The field is reduced to zero in 0.1 s. The induced emf in the coil is:  
 (a) 1 V (b) 5 V (c) 50 V (d) Zero
33. A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet while its motion is:  
 (a) Equal to that due to gravity (b) Less than due to gravity  
 (c) More than due to gravity (d) Depends on the diameter of the ring and the length of the magnet
34. Quantity that remains unchanged in a transformer is:  
 (a) Voltage (b) Current (c) Frequency (d) None of the above
35. The maximum induced emf in A.C. generator is given by:  
 (a)  $N\omega AB$  (b)  $NfAB$  (c)  $2\pi NfAB$  (d) Both a and c
36. If the flux associated with a coil of 100 turns varies at the rate of  $240\text{ Wb/min}$ , the emf induced is:  
 (a) 40 V (b) 400 V (c)  $\frac{1}{40}$  (d) Zero
37. A transformer is used to light 100 W 25 volt lamp from 250 Volt ac mains. The current in the main cable is 0.5 A. Calculate the efficiency of the transformer:  
 (a) 50 % (b) 60% (c) 90% (d) 80%
38.  $\text{emf} = -N(\Delta\Phi/\Delta t)$  is according to:  
 (a) Ampere's Law (b) Faraday's Law (c) Lenz's Law (d) None of these

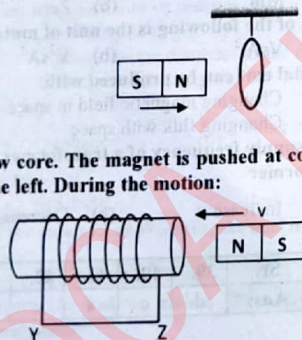
Sr.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.
Ans:	b	b	c	a	c	c	d	a	b	b	c	d	b	d	b

39. The transformer laminations are insulated from each other by:  
 (a) Mica strip (b) Paper  
 (c) Thin coating of Varnish (d) Any of the above
40. For current changing with time will produce \_\_\_ field:  
 (a) Electrostatic (b) Magnetostatic (c) Electromagnetic (d) None of these
41. Primary and secondary powers of a transformer are 200W and 100W respectively, the efficiency of a transformer is  
 (a) 50% (b) 1 (c) 20% (d) 10%
42. For an efficient step-down transformer  
 (a) Voltage in primary and secondary are equal  
 (b) Current in primary and secondary are equal  
 (c) Input power is same as the output power  
 (d) Output power is zero
43. Energy stored in an inductor is  
 (a) Electric energy (b) Magnetic energy  
 (c) Electromagnetic energy (d) Both a and b
44. According to Faraday's Law, emf induced in circuit depends on:  
 (a) Max. magnetic flux (b) Rate of change of magnetic flux  
 (c) Change in magnetic flux (d) Initial flux
45. A 100 turn coil of area  $0.1\text{ m}^2$  rotates at half a revolution per second. It is placed in a uniform magnetic field of  $0.01\text{ T}$  perpendicular to the axis of rotation of the coil. Calculate the maximum voltage generated in the coil?  
 (a) 256.33 V (b) 89.12 V  
 (c) 0.314 V (d) 3.1455 V
46. In step up transformer \_\_\_ is increased in secondary coils  
 (a) Electric field (b) Magnetic field  
 (c) Number of turns (d) None of these
47. Power transfer from primary to secondary is through flux linkage, so the primary and secondary coils should be wound in such a way that flux coupling between them is  
 (a) Min (b) Zero (c) Constant (d) Max
48. Which of the following is the unit of mutual inductance?  
 (a)  $\text{VsA}^{-2}$  (b)  $\text{V}^3\text{sA}^2$  (c)  $\text{V}^2\text{s}$  (d)  $\text{VsA}^{-1}$
49. Motional emf can be produced with  
 (a) Changing magnetic field in space (b) Changing magnetic field in time  
 (c) Changing flux with space (d) Constant magnetic field
50. If the supply frequency of a transformer increase, the secondary output voltage of the transformer  
 (a) Increase (b) Decrease (c) Remains unchanged (d) Any of above

Sr.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	d	c	a	c	b	b	c	c	d	d	c	c

## PRACTICE TEST NO. 3

- It is desired to make an A.C generator that can produce an emf of maximum value 5 kV with 50 Hz frequency. A coil of area  $1 \text{ m}^2$  having 200 turns is used as armature. What is the magnitude of magnetic field in which the coil rotates?  
(a) 0.04 T (b) 0.20 T (c) 0.08 T (d) 0.50 T
- In Faraday's law  $\varepsilon = -N \frac{\Delta\phi}{\Delta t}$ , then negative sign indicates that:  
(a) Direction of induced emf is such that it opposes the change in flux  
(b) Direction of induced emf is such that it favors the change in flux  
(c) Emf induced is decreasing  
(d) All of these
- If frequency of rotation of A.C generator is 60 Hz, how many times alternating current will reach to maximum value in one second?  
(a) 60 (b) 120 (c) 240 (d) 180
- When a magnet was pushed towards a solenoid, the meter connected to the solenoid showed a deflection to the right, when the same magnet was pulled away from the solenoid at the same speed, what was the deflection on the meter?  
(a) Greater and to the right (b) The same and to the right  
(c) The same but to the left (d) Zero
- The rod of unit length is moving at  $30^\circ$  through a magnetic field of 1 T. If velocity of rod is 1 m/s, then induced emf in the rod will be given by:  
(a) 1 V (b) 0.5 V (c) 0.25 V (d) 0.6 V
- A magnetic field of induction 10 T acts at right angle to a coil of area  $100 \text{ cm}^2$  with 200 turns and having a resistance of  $10 \Omega$ . The coil is removed at a uniform rate from the field in 0.5 sec. the induced current is  
(a) 0.4 A (b) 4 A (c) 1 A (d) 40 A
- A copper ring is suspended by a thread in a vertical plan. The north pole of a magnet is brought near the ring in horizontal direction as shown. What will be of effect on the ring?  
(a) Ring will be attracted towards the magnet  
(b) Ring will be repelled away  
(c) Ring will make simple harmonic motion  
(d) No change in the position of ring
- In the following diagram, X is a coil with a hallow core. The magnet is pushed at constant speed of from the right end into core and out again at the left. During the motion:



- Current in wire YZ will be from Y to Z
- Current in wire YZ will be from Z to Y
- Current in wire YZ will be from Z to Y and then from Y to Z
- Current in wire YZ will be from Y to Z and then from Z to Y

Sr.	1.	2.	3.	4.	5.	6.	7.	8.
Ans:	c	a	b	c	b	b	b	d

- A straight wire of length 0.20 m moves at a steady speed of  $3.0 \text{ m s}^{-1}$  at right angle to the magnetic field of flux density 0.10 T, the emf induced across the ends of wire as:  
(a) 0.5 V (b) 0.06 V (c) 0.05 V (d) 0.04 V
- A coil having number of turns  $N$  and cross-sectional area  $A$  is rotated in a uniform magnetic field  $B$  with an angular velocity  $\omega$ . The maximum value of the emf induced in it is:  
(a)  $\frac{NBA}{\omega}$  (b)  $NBA\omega$  (c)  $\frac{NBA}{\omega^2}$  (d)  $NBA\omega^2$
- The induced current in A.C generator of frequency 50 Hz reaches to zero value \_\_\_\_\_ times per second.  
(a) 100 (b) 25 (c) 50 (d) 75
- The general expressions of induced emf by A.C generator is given as:  
(a)  $\varepsilon = N\omega AB \sin \theta$  (b)  $\varepsilon = N\omega AB \tan \theta$   
(c)  $\varepsilon = N\omega AB \cos \theta$  (d)  $\varepsilon = N\omega AB \sec \theta$
- In A.C generator, which of the following is not used?  
(a) Armature (b) Field magnet (c) Stator (d) Armature
- While discussing motional emf in a conductor moving in uniform magnetic field, the electric and magnetic force on charge particle in that conductor are at:  
(a)  $0^\circ$  (b)  $180^\circ$  (c)  $90^\circ$  (d)  $45^\circ$
- Mathematical form of Faraday's law is:  
(a)  $\varepsilon = -N \frac{\Delta B}{\Delta t}$  (b)  $\varepsilon = -N \frac{\Delta \phi}{\Delta t}$  (c)  $\varepsilon = N \frac{\Delta \phi}{\Delta t}$  (d)  $\varepsilon = N \frac{\Delta B}{\Delta t}$
- In a transformer the primary has 500 turns and secondary has 50 turns. 100 volts are applied to the primary coil, the voltage developed in the secondary will be:  
(a) 1 V (b) 10 V (c) 1000 V (d) 10000 V
- A transformer is employed to reduce 220 V to 11 V. The primary draws a current of 5 A and the secondary 90 A. The efficiency of the transformer is:  
(a) 20% (b) 40% (c) 70% (d) 90%
- The transformer ratio in the step-up transformer is:  
(a) 1 (b) Greater than 1 (c) Less than 1 (d) Depends upon output power
- If rotational velocity of a dynamo armature is doubled, then induced emf will become:  
(a) Half (b) Two times (c) Four times (d) Unchanged
- Which of the following is constructed on the principle of electromagnetic induction?  
(a) Galvanometer (b) Electric motor (c) Generator (d) Voltmeter
- A conducting rod of length  $\ell$  is falling with a velocity  $v$  perpendicular to a uniform horizontal magnetic field  $B$ . The potential difference between the two ends will be:  
(a)  $2B\ell v$  (b)  $B\ell v$  (c)  $\frac{1}{2}B\ell v$  (d)  $B^2\ell^2 v^2$
- A 10 meter wire falling with velocity  $5 \text{ ms}^{-1}$  if length is perpendicular to the field  $0.3 \times 10^{-4} \text{ Wbm}^{-2}$ . The induced emf across the terminal will be:  
(a) 0.15 V (b) 1.5 V (c) 1.5 mV (d) 15.0 V
- If a coil of metal wire is kept stationary in a non-uniform magnetic field then:  
(a) An emf is induced in the coil (b) A current is induced in the coil  
(c) Neither emf nor current is induced (d) Both emf and current is induced
- The unit of magnetic flux is:  
(a)  $\text{Wbm}^{-2}$  (b) Wb (c) Henry (d)  $\text{Am}^{-1}$
- A coil having 500 square loops each of side 10cm is placed normal to a magnetic flux which increase at the rate of  $1 \text{ Ts}^{-1}$ . The induced emf in volts is:  
(a) 0.1 (b) 1 (c) 0.5 (d) 5

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
Ans:	b	b	a	a	c	b	b	b	d	b	b	c	b	c	c	b	d

26. A coil having an area  $A_p$  is placed in a magnetic field which changes from  $B_0$  to  $4B_0$  in a time interval  $t$ . The emf induced in the coil will be:
- (a)  $\frac{3A_p B_0}{t}$  (b)  $\frac{4A_p B_0}{t}$  (c)  $\frac{3B_0}{A_p t}$  (d)  $\frac{4B_0}{A_p t}$
27. Lenz's law is consequence of the law of conservation of:
- (a) Charge (b) Momentum (c) Mass (d) energy
28. In a step up transformer the ratio of voltages is 20. If the voltage across primary is 110 V, the voltage across the secondary will be:
- (a) 1500 V (b) 2400 V (c) 1800 V (d) 2200 V
29. The ratio of the number of turns in primary to secondary coil of a transformer is 7:19. The ratio of the power in the primary and secondary coils will be:
- (a) 19:7 (b) 1:19 (c) 7:19 (d) 1:1
30. The ratio of the secondary to the primary turns in a transformer is 5:6 and the output power is P. Neglecting all power losses, what is the ratio of input to output current?
- (a) 1:1 (b) 5:6 (c) 9:6 (d) 6:5
31. In a step-up transformer, the turns ratio is 1:10. A resistance of 200 ohm connected across the secondary is drawing a current of 0.5 A. What is the primary voltage and current?
- (a) 50 V, 1 A (b) 10 V, 5 A (c) 25 V, 4 A (d) 20 V, 2 A
32. Efficiency of a transformer is affected by:
- (a) Core of transformer (b) Insulations between plates  
(c) Resistance of coils (d) All of these
33. Condition for a step-down transformer:
- (a)  $N_s < N_p$  (b)  $N_s > N_p$  (c)  $N_s = N_p$  (d)  $N_p \geq N_s$
34. The power input to a main transformer is 100 W. If the primary current is 5 A, the secondary voltage is 10 V and assuming no losses in transformer, the turns ratio of primary to secondary is:
- (a) 4:1 step-up (b) 4:1 step-down (c) 2:1 step-up (d) 2:1 step-down
35. Which quantity is decreased in step-up transformer?
- (a) Current (b) Voltage (c) Power (d) Frequency
36. In an ideal transformer, the voltage and the current in the primary are 200 V, 2 A and those in the secondary are 2000 V, 1 A. The value of I is:
- (a) 0.2 (b) 1 (c) 20 (d) 2
37. The energy used to magnetize and demagnetize the core of transformer causes power loss which is due to:
- (a) Hysteresis (b) Eddy current  
(c) Winding in coil of transformer (d) All of these
38. In a transformer, the number of turns of primary coil and secondary coil are 20 and 15 respectively. If 220 V is applied on primary coil, then the ratio of current in secondary to primary coil is:
- (a) 3:4 (b) 8:3 (c) 4:3 (d) 3:8
39. An ideal step-up transformer is one which:
- (a) Decrease current level (b) Keeps power level  
(c) Increases voltage level (d) All of these
40. The core of a transformer is laminated to reduce:
- (a) Copper loss (b) Eddy current loss  
(c) Magnetic loss (d) Hysteresis loss
41. The efficiency of a transformer which take input power of 20 W is 70%, the power supplied by this transformer on output side is:
- (a) 12 W (b) 20 W (c) 14 W (d) 28 W

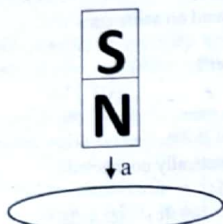
Sr.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.
Ans:	a	d	d	d	b	b	d	a	d	a	a	a	c	d	b	c

42. The resistance of winding of transformer can be decreased by increasing:
- (a) Laminated iron core (b) Diameter of wire  
(c) Magnetic field (d) Length of wire
43. For an efficient transformer, the hysteresis loop for its core has:
- (a) Infinite area (b) Smaller area (c) Zero area (d) Larger area
44. What is true for a transformer for its greater efficiency:
- (a) Two coils of Copper are wound on different cores  
(b) Two coils of silver are wound on same core  
(c) Two electrically connected coils are wound on same core  
(d) All of these
45. Out of following, what is true for a transformer?
- (a) Coils are electrically connected  
(b) Coils are electrically insulated  
(c) Coils are magnetically insulated  
(d) Coils are electrically insulated but magnetically connected
46. For an ideal transformer, what is true?
- (a)  $\frac{V_s}{V_p} = \frac{I_p}{I_s}$  (b)  $\frac{N_p}{N_s} = \frac{V_p}{V_s}$  (c)  $\frac{I_p}{I_s} = \frac{N_s}{N_p}$  (d) All of these
47. A transformer has 100 windings in primary and 200 windings in the secondary. The primary is connected to A.C supply of 120 V at 10 A. check the correct situation for this transformer out of the following:
- (a) The secondary voltage is 240 V and current is 20 A  
(b) The secondary voltage is 240 V and current is 5 A  
(c) The secondary voltage is 60 V and current is 20 A  
(d) The secondary voltage is 60 V and current is 5 A
48. Transformer is an example of:
- (a) Statically induced emf (b) Motional emf  
(c) Dynamically induced emf (d) All of these
49. In an ideal transformer connected to 240 V A.C, having primary of turns 1000 and secondary of turns 500. The output connected to load of 100 ohm. The current through load:
- (a) 1.2 A (b) 12 A (c) 0.6 A (d) zero
50. An ideal step-up transformer has a turn ratio of 10:1 and is supplied at 100 V when the primary current is 5 A. Which of the following statement is false?
- (a) The transformer rating is 0.5 kV A  
(b) The secondary voltage is 1000 V  
(c) The secondary current is 0.5 A  
(d) The secondary power rating is less than 500 W

Sr.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	b	b	d	d	b	a	a	d

## PRACTICE TEST NO. 4

1. In electromagnetic induction, the current induced emf in a coil is independent of:  
 (a) Change in flux (b) Time (c) Resistance of circuit (d) None of the above
2. When the north pole of a magnet is brought near the coil, viewing above the induced current in the ring will be:



- (a) First clockwise then anticlockwise (b) In clockwise direction  
 (c) In anticlockwise direction (d) First anticlockwise then clockwise
3. The direction of induced emf during electromagnetic induction is given by:  
 (a) Faraday's law (b) Lenz's law (c) Maxwell's law (d) Ampere's law
4. According to Faraday's law of electromagnetic induction:  
 (a) The direction of induced current is such that it opposes the cause producing it  
 (b) The magnitude of induced emf produced in a coil is directly proportional to the rate of change of magnetic flux  
 (c) Induced current always decrease the  $\Phi$   
 (d) Induced current always increase  $\Phi$
5. The north pole of a magnet is brought near a magnet ring. Viewing from magnetic side the direction of the induced current in the ring will be:  
 (a) Clockwise (b) Anticlockwise (c) Towards north (d) Towards south
6. Magnetic flux in a circuit containing a coil of resistance  $2\Omega$  changes from  $2\text{ Wb}$  to  $10\text{ Wb}$  in  $0.2\text{ sec}$ . The charge passed through the coil in this time is:  
 (a)  $0.8\text{ C}$  (b)  $1.0\text{ C}$  (c)  $5.0\text{ C}$  (d)  $4.0\text{ C}$
7. A coil of area  $80\text{ cm}^2$  and  $50$  turns is rotating with  $2000$  revolutions per minute about an axis perpendicular to a magnetic field of  $0.05\text{ Tesla}$ . The maximum value of emf developed in it is:  
 (a)  $200\pi\text{ volt}$  (b)  $\frac{10\pi}{3}\text{ volt}$  (c)  $\frac{4\pi}{3}\text{ volt}$  (d)  $\frac{2}{3}\text{ volt}$
8. A circular metal plate of radius  $R$  is rotating with a uniform angular velocity  $\omega$  with its plane perpendicular to a uniform magnetic field  $B$ . Then the emf developed between the center and the rim of the plate is:  
 (a)  $\pi\omega BR^2$  (b)  $\omega BR^2$  (c)  $\frac{\pi\omega BR}{2}$  (d)  $\frac{\pi Br^2}{2}$
9. Eddy current are produced when:  
 (a) A metal is kept in varying magnetic field (b) A metal is kept in the steady magnetic field  
 (c) A circular coil is placed in a magnetic field (d) Through a circular coil, current is passed

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Ans:	c	c	b	b	b	d	c	a	a

10. In transformer, core is made of soft iron to reduce?  
 (a) Hysteresis losses (b) Eddy current losses  
 (c) Force opposing electric current (d) None
11. The primary winding of a transformer has  $100$  turns and its secondary winding has  $200$  turns. The primary is connected to an AC supply of  $120\text{ volts}$  and the current flowing in it is  $10\text{ A}$ . The voltage and the current in the secondary are:  
 (a)  $240\text{ V}, 5\text{ A}$  (b)  $240\text{ V}, 10\text{ A}$  (c)  $60\text{ V}, 20\text{ A}$  (d)  $120\text{ V}, 20\text{ A}$
12. A transformer connected to  $220\text{ volt}$  lines shows an output of  $2\text{ A}$  at  $11000\text{ volt}$ . The efficiency is  $100\%$ . The current drawn from the line is:  
 (a)  $100\text{ A}$  (b)  $200\text{ A}$  (c)  $22\text{ A}$  (d)  $11\text{ A}$
13. A step up transformer has transformation ratio  $5:3$ . What is voltage in secondary if voltage in primary is  $60\text{ V}$ .  
 (a)  $20\text{ V}$  (b)  $60\text{ V}$  (c)  $100\text{ V}$  (d)  $180\text{ V}$
14. "The direction of induced current is always so as to oppose the cause of that procures it", is a statement of:  
 (a) Lenz's law (b) Boyle's law (c) Faraday's law (d) Ohm's law
15. The coil of A.C generator is also known as:  
 (a) Commutator (b) Field magnet (c) Stator (d) Armature
16. In armature coil of A.C generator, the emf induced in two sides is taken as zero because force experienced by charges in these sides is:  
 (a) Along the sides of the wires (b) Always zero  
 (c) Perpendicular & not along sides of the wires (d) All of these
17. The current induced by A.C generator depends upon:  
 (a) Area of armature coil (b) Angular frequency of armature coil  
 (c) Number of turns of armature coil (d) All of these
18. A cylindrical bar magnet is kept along the axis of a circular coil. If the magnet is rotated about its axis, then:  
 (a) A current will be induced in the coil  
 (b) No current will be induced in the coil  
 (c) Only an emf will be induced in the coil  
 (d) Both a current and an emf will be induced in the coil
19. Lenz law is in accordance with:  
 (a) Law of conservation of momentum  
 (b) Law of conservation of angular momentum  
 (c) Law of conservation of K.E  
 (d) Law of conservation of energy
20. A circular coil has area  $A$  and is placed in a uniform magnetic field such that its plane is perpendicular to the lines of force of the magnetic field. If the magnetic field has magnitude  $B$  and the plane of the coil is turned through  $180^\circ$  about an axis perpendicular to the magnetic field in a time  $t$ , what is the magnitude of the induced e.m.f?  
 (a) Zero (b)  $\frac{BA}{t}$  (c)  $\frac{2BA}{t}$  (d)  $\frac{BA}{2t}$
21. In electromagnetic induction, the induced emf is independent of:  
 (a) Change in flux (b) Resistance of circuit  
 (c) Time (d) Number of turns
22. A generator produces a voltage that is given by  $V = 220 \sin 314 t$  volt, where time " $t$ " is in second. The frequency of this voltage is:  
 (a)  $55\text{ Hz}$  (b)  $19\text{ Hz}$  (c)  $60\text{ Hz}$  (d)  $50\text{ Hz}$

Sr.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Ans:	a	a	a	c	a	d	c	d	d		c	b	d

23. A rectangular loop of wire has area  $A$ . It is placed perpendicular to a uniform magnetic field  $B$  and then spin around one of its sides at frequency  $f$ . The maximum induced emf is:  
 (a)  $BAf$  (b)  $10BAf$  (c)  $2BAf$  (d)  $2\pi BAf$
24. The armature of generator has 150 turns and its area  $200 \text{ cm}^2$ . If it rotates with frequency 60 Hz in  $0.15 \text{ T}$  magnetic field, the maximum emf induced is:  
 (a) 170 V (b) 340 V (c) 65 V (d) 85 V
25. The induced current in a circuit:  
 (a) Decreases the magnetic flux through the circuit  
 (b) Increases the magnetic flux through the circuit  
 (c) May increase or decrease the magnetic flux through the circuit  
 (d) Leaves the magnetic flux through the circuit unchanged
26. Instantaneous value of alternating voltage produced by A.C generator is given by:  
 (a)  $V_0 \cos \omega t$  (b)  $V_0 \tan \omega t$  (c)  $V_0 \sin \omega t$  (d)  $V_0 \sec \omega t$
27. If the speed of rotation of a generator is doubled the output voltage will be:  
 (a) Remain same (b) Double (c) Four time (d) One half
28. Mutual inductance has a practical role in performance of  
 (a) AC generator (b) Radio choke  
 (c) DC generator (d) Transformer
29. If we make the magnetic field stronger, the value of induced current is  
 (a) Decreased (b) Increased  
 (c) Vanished (d) Kept constant
30. Henry is unit of  
 (a) Self inductance only (b) Mutual inductance  
 (c) Both a and b (d) emf
31. Which of the following remains unchanged in transformer?  
 (a) Voltage (b) Current (c) Power (d) All of these
32. In step up transformer  
 (a)  $V_s/V_p = 1$  (b)  $V_s < V_p$  (c)  $V_s = V_p$  (d)  $V_s > V_p$
33. If the flux passing through a coil per unit time is doubled then motional emf also  
 (a) Halves (b) Triples (c) Doubles (d) Remains unchanged
34. The 220 Volts mains supply is stepped down to 11 volt, what is the transformation ratio?  
 (a) 1:20 (b) 20:1 (c) 1:2 (d) 2:5
35. Core of transformer is made up of:  
 (a) Copper (b) Aluminum (c) Iron (d) Steel
36. If number of loops are increased then according to Faraday law \_\_\_\_\_ will increase:  
 (a) Voltage (b) Electric field (c) Magnetic field (d) All of these
37. A coil of metal wire connected with galvanometer is kept stationary in a magnetic field whose magnitude is continuously changing and direction is always perpendicular to plane of coil then:  
 (a) An emf is induced in the coil (b) A current is induced in the coil  
 (c) Neither emf nor current is induced (d) Both A and B
38. The unit of induced e.m.f. is:  
 (a) Ampere (b) Watt (c) Volt (d) Weber
39. A wire of length  $1.0 \text{ m}$  moves with a speed of  $10 \text{ ms}^{-1}$  perpendicular to a magnetic field. If the emf induced in the wire is  $1.0 \text{ V}$ , the magnitude of the field is:  
 (a)  $0.01 \text{ T}$  (b)  $0.2 \text{ T}$  (c)  $0.1 \text{ T}$  (d)  $0.02 \text{ T}$

Sr.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.
Ans:	d	a	c	c	b	d	b	c	c	d	c	a	c	d	d	c	c

40. A coil is rotated in a uniform magnetic field about an axis perpendicular to the field. The emf induced in the coil would be minimum when the plane of the coil is:  
 (a) Parallel to the field (b) Perpendicular to the field  
 (c) At  $45^\circ$  to the field (d) None of them
41. Which of the following is not present in A.C generator?  
 (a) Slip rings (b) Carbon brushes (c) Magnetic field (d) Split rings
42. In A.C generator, when coil is parallel to magnetic field the induced current is:  
 (a) Maximum (b) Minimum  
 (c) Half of maximum (d) Infinite
43. An A.C generator is operating at 50 Hz with a coil having 200 turns. The angular frequency/speed of coil is:  
 (a)  $3.14 \text{ rad s}^{-1}$  (b)  $314 \text{ rad s}^{-1}$  (c)  $628 \text{ rad s}^{-1}$  (d)  $6.28 \text{ rad s}^{-1}$
44. When angle between velocity and magnetic field is  $45^\circ$ , the emf produced by A.C generator is:  
 (a)  $\frac{E_0}{2}$  (b)  $\frac{E_0}{\sqrt{2}}$  (c)  $\frac{\sqrt{3}}{2} E_0$  (d)  $E_0$
45. A metal rod of length  $4 \text{ m}$ , velocity  $5 \text{ m/s}$  and magnetic field  $0.5 \text{ T}$  induced emf is:  
 (a) 10V (b) 20V (c) 30V (d) 4V
46. A transformer steps down from 200 V to 50 V. It has secondary winding = 40 turns, then windings in primary coil are  
 (a) 150 (b) 160 (c) 170 (d) 200
47. For long distance electrical power transmission, it is necessary to use \_\_\_\_\_ to minimize power loss in transmission lines:  
 (a) High voltage and high current (b) Low voltage and high current  
 (c) Low voltage and low current (d) High voltage and low current
48. The voltage received in customer's household wires is usually \_\_\_\_\_ in Pakistan:  
 (a) 66 kV (b) 132 kV (c) 220 V (d) 11 kV
49. The necessary voltage conversions in electrical power transmission system is done by:  
 (a) Transformer (b) Motor (c) Generator (d) Dynamo
50. The working principle of transformer is based on:  
 (a) Self induction (b) Faraday's law  
 (c) Mutual induction (d) Lenz's law
51. Transformer possesses:  
 (a) Electrically connected two coils (b) Coils wound on soft iron core  
 (c) Magnetically linked two coils (d) Both B and C
52. The function of soft iron core in transformer is:  
 (a) To enhance flux linkages between coils  
 (b) To provide medium such that all flux through one coil passes through other  
 (c) To electrically insulate the two coils  
 (d) Both A and B
53. An ideal transformer is the one which has:  
 (a) No losses (b) Coils with no resistance  
 (c) Pure inductive coils (d) All of these
54. In an ideal transformer, the ratio of rate of change of flux in primary to rate of change of flux through secondary coil is:  
 (a) Equal to zero (b) Greater than one  
 (c) Equal to one (d) Less than one
55. The coil of the transformer connected to the load resistor is called:  
 (a) Primary coil (b) Tertiary coil (c) Secondary coil (d) Resistive coil

Sr.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.
Ans:	b	d	a	b	b	a	b	d	a	a	c	d	d	d	c	c

56. Power losses in practical transformer are due to:

- (a) Eddy currents & Hysteresis loss  
(b) Magnetic loss & Iron loss  
(c) Flux leakage & Resistance of coils  
(d) All of these

57. The percentage efficiency of a transformer can be calculated by:

- (a)  $\eta = \frac{P_{out}}{P_{in}} \times 100\%$   
(b)  $\eta = \frac{V_{out}}{V_{in}} \times 100\%$   
(c)  $\eta = \frac{P_{in}}{P_{out}} \times 100\%$   
(d)  $\eta = \frac{V_{in}}{V_{out}} \times 100\%$

58. The power loss due to flux leakage in a transformer can be reduced by:

- (a) Using thick wire for winding of the coil  
(b) Using laminated iron sheets stacked together as core  
(c) Winding the two coils one over another  
(d) Using step-up transformer

59. In a step-up transformer:

- (a) Secondary voltage is greater than primary voltage  
(b) Secondary power is greater than primary power  
(c) Primary turns are greater than secondary turns  
(d) Primary current is lesser than secondary current

60. A transformer steps up 220 volt to 2200 volt. If the secondary coil of a transformer has 100 turns, the number of turns in the primary coil is:

- (a) 10  
(b) 100  
(c) 20  
(d) 500

61. If a step up transformer were 100% efficient, the primary and secondary winding would have the same:

- (a) Current  
(b) Number of turns  
(c) Power  
(d) Voltage

62. Step-up transformer has a transformation ratio of 2:3. What is the voltage in secondary, if voltage in primary is 40 V?

- (a) 60 V  
(b) 90 V  
(c) 15 V  
(d) 120 V

63. The core of any transformer is laminated so as to:

- (a) Reduce the energy due to eddy currents  
(b) Make it robust and strong  
(c) Make it light weight  
(d) Increase the secondary voltage

64. In a transformer, number of turns in primary coil are 140 and that of the secondary coil are 280. If current in primary coil is 8 A, then that of the secondary coil is:

- (a) 4 A  
(b) 6 A  
(c) 2 A  
(d) 10 A

65. A step-up transformer has turn ratio of 25. If the output current is 10 A, the input current is:

- (a) 0.4 A  
(b) 2.5 A  
(c) 35 A  
(d) 250 A

66. The efficiency of a transformer which take input power of 200 W is 80%, the power supplied by this transformer on load side is:

- (a) 120 W  
(b) 140 W  
(c) 200 W  
(d) 160 W

67. Step-up transformer has turn ratio of 6:2. What is the voltage in the secondary, if the voltage in primary is 40 V:

- (a) 40 V  
(b) 120 V  
(c) 60 V  
(d) 90 V

68. In a step-up transformer, the turns ratio is 1:4. A 1.5V battery is connected across the primary. The voltage across the secondary is:

- (a) 3.0  
(b) Zero  
(c) 0.75 V  
(d) 1.5 V

69. A step-up transformer operates on a 200 volt line and supplies a current of 2 ampere. The ratio of primary and secondary winding is 1:5. The output voltage in the secondary is:

- (a) 200 V  
(b) 40 V  
(c) 1000 V  
(d) 1100 V

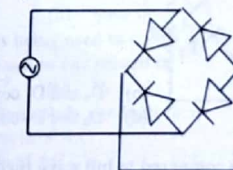
Sr.	56.	57.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.	68.	69.
Ans:	d	a	c	a	a	c	a	a	a	d	d	b	a	c

## UNIT 10 &gt;&gt;

## ELECTRONICS

## PRACTICE TEST NO. 1

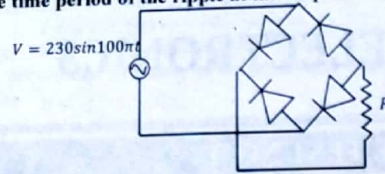
- Peak voltage in the output of full wave rectifier is 10V so DC component of output voltage is  
(a)  $10\sqrt{2}$  (b)  $20/\sqrt{2}$  (c)  $20/\pi$  (d)  $20\pi$
- Rectifier is a device which converts  
(a) AC to DC (b) DC to AC  
(c) AC to triangular current (d) DC to triangular current
- If a half wave rectifier is used to convert 50Hz AC into DC, then the number of pulses present in rectifier voltage is  
(a) 25 (b) 50 (c) 100 (d) 75
- A full wave rectifier is operating from 50 Hz mains. Fundamental frequency of ripple will be:  
(a) 100 Hz (b) 25 Hz (c) 50 Hz (d) 200 Hz
- In which rectifier ripple factor is less  
(a) Full wave (b) Half wave (c) Both A and B (d) None of them
- In full wave bridge rectification number of diodes required are equal to:  
(a) 3 (b) 5 (c) 4 (d) 1
- For a half waver rectifier, the input and output waveforms are shown as:  
The time period of the output will be  
(a) 5 ms (b) 15 ms (c) 10 ms (d) 20 ms
- A full wave rectifier is being used to rectify an A.C voltage of 110 V, 60 Hz. The number of pulses of rectified current obtained in five seconds is:  
(a) 300 (b) 60 (c) 600 (d) 120
- In a full-wave center tap transformer rectifier, how many diodes conduct at a time?  
(a) 1 (b) 2 (c) 3 (d) 4
- A half wave rectifier is being used to rectify an A.C voltage of frequency 60 Hz. The number of pulses of rectified current obtained in two seconds is:  
(a) 60 (b) 240 (c) 120 (d) 30
- The following circuit represents:



- (a) Half wave rectifier  
(b) Full waver rectifier  
(c) Quarter waver rectifier  
(d) None of these
- The time period of an A.C cycle is 10 s such that it is allowed to go through a bridge rectifier then the frequency of output ripple will be:  
(a) 0.5 Hz (b) 0.2 Hz (c) 0.1 Hz (d) 0.4 Hz
  - The minimum number of diodes required for half wave rectification are:  
(a) 4 (b) 1 (c) 2 (d) 3

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Ans:	c	a	a	a	a	c		c	a	c	b	b	b

14. The time period of the ripple at the output of the following circuit is:

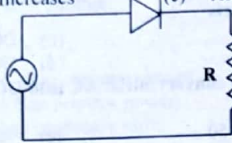
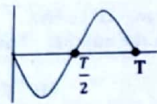


- (a) 100 ms (b) 20 ms (c) 50 ms (d) 10<sup>-5</sup> ms

15. The width of depletion region during forward biased mode of a PN-junction diode:

- (a) Decreases (b) Increases (c) Remains same (d) None of these

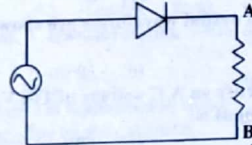
16. If is given to following circuit:



The output voltage during  $0 \rightarrow \frac{T}{2}$  will be:

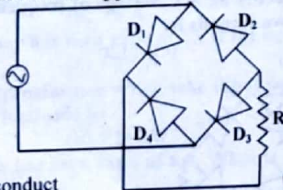
- (a) Positive half (b) Negative half  
(c) Zero (d) A.C

17. In the circuit shown, which terminal of output becomes negative during the conduction mode of the diode:



- (a) A (b) B  
(c) Either A or B (d) Can not be predicted

18. In the following figure what happens for the negative half cycle of the input?



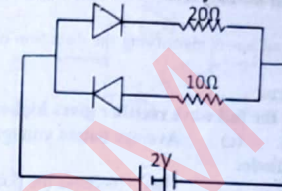
- (a) D<sub>1</sub> and D<sub>3</sub> conduct (b) D<sub>4</sub> and D<sub>2</sub> conduct  
(c) D<sub>1</sub> and D<sub>2</sub> conduct (d) D<sub>4</sub> and D<sub>3</sub> conduct

19. Disadvantage of half wave rectification as compared to full wave rectification is:

- (a) Signal is not converted to DC  
(b) Power of half signal wasted (about 50%)  
(c) Pulsating DC is produced  
(d) Signal at output becomes triangular AC

Sr.	14.	15.	16.	17.	18.	19.
Ans:	d	a	c	b	b	b

20. In figure, the current supplied by the battery is:

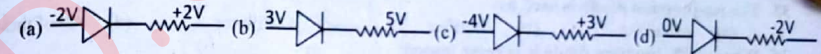


- (a) 0.1 A (b) 0.2 A (c) 0.3 A (d) 0.4 A

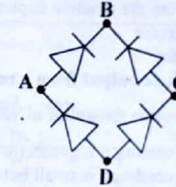
21. The basic reason why a full wave rectifier has twice efficiency than half wave rectifier because:

- (a) It uses transformer  
(b) Its ripple factor is much less  
(c) It uses both cycle as input  
(d) Output frequency is double the line frequency

22. Which of the following diode is not in reverse biased mode?



23. In the diagram, the input is across the terminals A and C and the output is across the terminals B and D, then the output is:



- (a) Zero (b) Same as input (c) Full wave rectifier (d) Half wave rectifier

24. If a full wave rectifier circuit is operating from 50 Hz mains, then the time period of output ripples will be:

- (a) 10 ms (b) 40 ms (c) 50 ms (d) 80 ms

25. The output voltage of a rectifier is:

- (a) Straight line (b) Smooth (c) Pulsating (d) None of these

26. A half wave rectifier is being used to rectify an alternating voltage of 50 Hz. The no. of pulses of rectified current obtained in one second is:

- (a) 50 (b) 25 (c) 100 (d) 200

27. In half wave rectification, diode conducts for:

- (a) Positive half cycle of A.C (b) Negative half cycle of AC  
(c) Complete cycle of AC (d) Either +ve or -ve half cycle of A.C

28. The process in which A.C is converted to D.C is called....., and the process in which D.C is converted to A.C is called:

- (a) Rectification, rectification (b) Rectification, inversion  
(c) Conversion, rectification (d) Inversion, inversion

Sr.	20.	21.	22.	23.	24.	25.	26.	27.	28.
Ans:	a	c	d	c	a	c	b	d	b

29. Which one of the following statements is not correct?

- (a) Diode does not obey ohm's law
- (b) PN junction diode symbol shows an arrow identifying the direction of current flow
- (c) Ideal diode is an open switch
- (d) Diode is an ideal one way conductor

30. In comparison of a half wave rectifier, the full wave rectifier gives higher:

- (a) Efficiency (b) Average dc (c) Average output voltage (d) All of these

31. The reverse biasing in a PN-junction diode:

- (a) Decrease the potential barrier
- (b) Increase the potential barrier
- (c) Increase the number of minority charge carriers
- (d) Increase the number of majority charge carriers

32. The cause of the potential barrier in a PN-junction diode is:

- (a) Depletion of positive charges near the junction
- (b) Concentration of positive charges near the junction
- (c) Depletion of negative charges near the junction
- (d) Concentration of positive and negative charges near the junction

33. The pn-junction diode is used as:

- (a) Amplifier (b) Rectifier (c) Oscillator (d) All of these

34. When a PN-junction diode is reverse biased:

- (a) Electrons and holes are attracted towards each other and move towards the depletion region.
- (b) Electrons and holes move away from the junction depletion
- (c) Height of the potential barrier decrease
- (d) No change in the current takes place

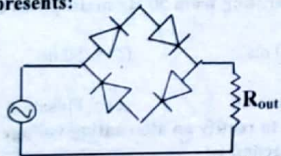
35. The electrical circuit used to get smooth dc output from a rectifier circuit is called:

- (a) Oscillator (b) filter (c) Amplifier (d) Logic gates

36. In a PN-junction diode:

- (a) The current in the reverse biased condition is generally very small
- (b) The current in the reverse biased condition is small but the forward biased current is independent of the biasing voltage
- (c) the reverse biased current is strongly dependent on the applied biasing voltage
- (d) The forward biased current is very small in comparison to reverse biased current

37. The following circuit represents:



- (a) Half wave rectifier
- (b) Full wave rectifier
- (c) Quarter wave rectifier
- (d) Not a rectifier

38. In a full wave bridge rectifier, how many diodes conduct at a time?

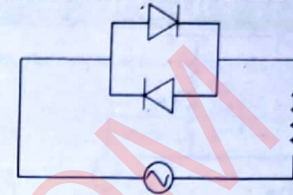
- (a) 1 (b) 2 (c) 3 (d) 4

39. If the time period of A.C source applied on the input of full wave rectifier is  $T_1$  and time period of the output ripple is  $T_0$ , then the relation between these two is:

- (a)  $T_0 = 2T_1$  (b)  $T_0 = \frac{T_1}{\sqrt{2}}$  (c)  $T_0 = \sqrt{2} T_1$  (d)  $T_1 = 2T_0$

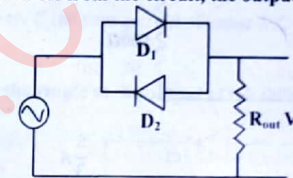
Sr.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.
Ans:	d	d	b	d	b	b	b	a	d	b	d

40. The output across resistor in the circuit shown will be:



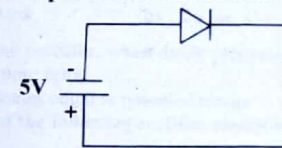
- (a)
- (b)
- (c)
- (d)

41. If the diode  $D_1$  is taken off from the circuit, the output across resistor will become?



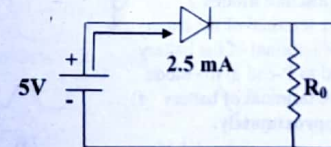
- (a) Half wave rectifier
- (b) Full wave rectifier
- (c) Zero
- (d) A.C

42. The potential drop across resistor in following circuit is:



- (a)  $(5 + 0.7) V$  (b)  $(5 - 0.7) V$  (c) 5V (d) Zero

43. If the diode resistance is negligible, the output resistance of following circuit  $R_0 = \dots\dots\dots$



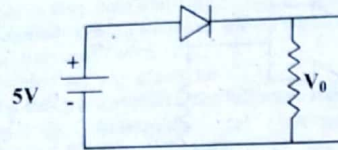
- (a) 1 K $\Omega$  (b) 3 K $\Omega$  (c) 2 K $\Omega$  (d) 5 K $\Omega$

44. The rms value of the output of full wave rectifier is:

- (a)  $\frac{V_o}{\sqrt{2}}$  (b)  $\frac{V_o}{\sqrt{3}}$  (c)  $\frac{V_o}{2}$  (d)  $\frac{V_o}{3}$

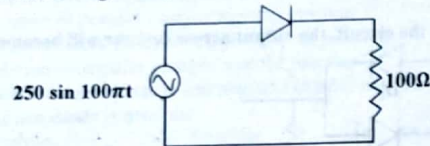
Sr.	40.	41.	42.	43.	44.
Ans:	d	d	d	c	a

45. In the following circuit, the output will be about:



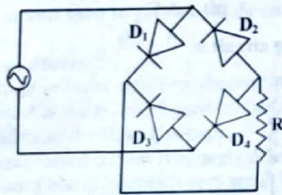
- (a) Pulsating D.C (b) Half wave rectifier D.C (c) Pure D.C (d) Pure A.C

46. The rms current flowing through the following circuit will be:



- (a)  $\frac{5}{2} A$  (b)  $\frac{5}{4} A$  (c)  $\frac{5}{3} A$  (d)  $\frac{5}{6} A$

47. In the following figure what happens for the positive half cycle of the input?



- (a)  $D_1$  and  $D_4$  conduct (b)  $D_1$  and  $D_2$  conduct  
(c)  $D_4$  and  $D_2$  conduct (d)  $D_4$  and  $D_3$  conduct

48. In the forward bias arrangement of a PN-junction diode:

- (a) The N-end is connected to the positive terminal of the battery  
(b) The P-end is connected to the positive terminal of the battery  
(c) The direction of current is from N-end to P-end in the diode  
(d) The P-end is connected to the negative terminal of battery

49. The potential barrier for silicon diode is approximately:

- (a) 0.3 V (b) 0.7 V (c) 1.1 V (d) 1.4 V

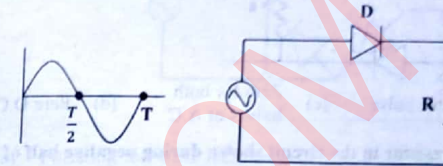
50. PN-junction diode works as a insulator if connected:

- (a) To A.C (b) In forward bias (c) In reverse bias (d) None of these

Sr.	45.	46.	47.	48.	49.	50.
Ans:	c	b	a	b	b	c

## PRACTICE TEST NO. 2

1. In the circuit shown, the output across resistor during  $(\frac{T}{2} - T)$  is:

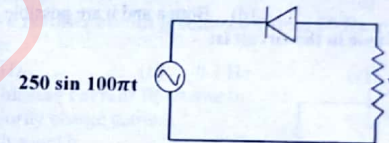


- (a) Positive pulse (b) Zero (c) Negative pulse (d) Either +ve or -ve pulse

2. In half wave rectifier, if the time period of input A.C is 50 ms, then the frequency of ripple at output in hertz is:

- (a) 50 (b) 30 (c) 40 (d) 20

3. The time period of the ripple at the output of the following circuit is:

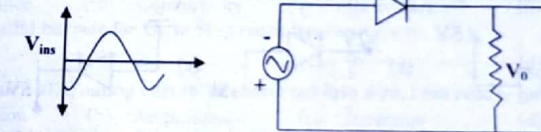


- (a) 100 ms (b) 20 ms (c) 50 ms (d) 10 ms

4. In a half wave rectifier, when diode gets reverse biased, the voltage across its terminals:

- (a) Become zero (b) Becomes equal to source voltage  
(c) Becomes equal to potential barrier (d) None of these

5. The output of the following rectifier circuit will be:



- (a) (b) (c) (d)

6. The electrical resistance of depletion layer is larger because:

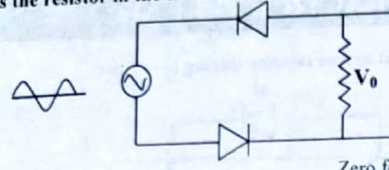
- (a) It has no charge carriers (b) It has a large number of charge carriers  
(c) It increases the number of minority charge carriers (d) Increases the number of majority charge carriers

7. In a junction diode, the holes are due to:

- (a) Protons (b) Neutrons (c) Extra electrons (d) Missing electrons

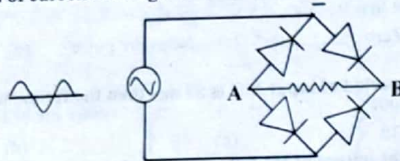
Sr.	1.	2.	3.	4.	5.	6.	7.
Ans:	b	d	b	b	a	a	d

8. The output across the resistor in the circuit shown for positive half of A.C source will be:



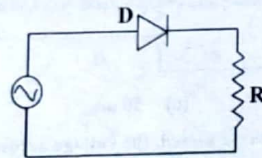
- (a) Positive pulse (b) Negative pulse (c) Zero for both halves of A.C (d) Pure D.C

9. The direction of current through the resistor in the circuit shown during negative half of A.C will be:



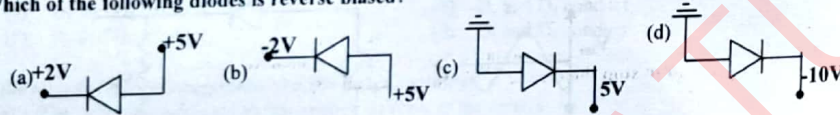
- (a) From A to B (b) No current flows during negative half (c) From B to A (d) Both a and b are possible

10. During the positive half of A.C the diode in the circuit is:

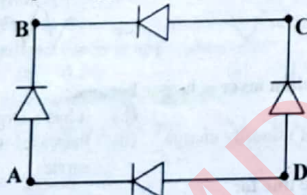


- (a) Forward biased (b) Open (c) Reverse biased (d) None of these

11. Which of the following diodes is reverse biased?



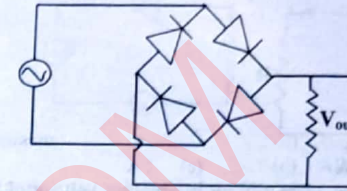
12. In the diagram shown, the input is applied between A and C and output is across B and D. Then the output is:



- (a) Half wave rectifier (b) Full wave rectifier (c) Zero (d) Same as input

Sr.	8.	9.	10.	11.	12.
Ans:	b	c	a	c	b

13. The output of the following circuit will be:



- (a) Pulsating full wave rectified D.C (b) Sinusoidal A.C (c) Pulsating half wave rectified D.C (d) Zero

14. The approximate ratio of resistance in the forward and reverse bias of the PN-junction diode is:

- (a)  $10^2:1$  (b)  $10^{-2}:1$  (c)  $1:10^6$  (d)  $1:10^8$

15. The resistance of a reverse biased PN-junction diode is about:

- (a) 1 ohm (b)  $10^2$  ohm (c)  $10^3$  ohm (d)  $10^6$  ohm

16. Function of rectifier is:

- (a) To convert ac into dc (b) To convert dc into ac (c) Both a, b (d) To give constant D.C

17. If a full wave rectifier circuit is connected from 50 Hz mains, the fundamental frequency of the ripple will be:

- (a) 50 Hz (b) 70.7 Hz (c) 100 Hz (d) 25 Hz

18. In forward biasing current flows due to:

- (a) Majority charge carriers (b) Minority charge carriers (c) Both a and b (d) Ions

19. A diodes characteristics curve is a plot between:

- (a) Voltage and time (b) Voltage and current (c) Current and time (d) All of these

20. In full wave bridge rectifier, minimum number of diodes required are:

- (a) Only one (b) Two (c) Three (d) Four

21. Slope of the reverse characteristics of a PN-junction represents its:

- (a) Conductance (b) Conductivity (c) Resistance (d) Resistivity

22. The ratio of potential barrier for Ge to Si at room temperature is:

- (a)  $\frac{3}{7}$  (b)  $\frac{7}{3}$  (c)  $\frac{2}{5}$  (d)  $\frac{1}{3}$

23. The process in which alternating current is converted into direct current is called:

- (a) Rectification (b) Amplification (c) Inversion (d) Complementation

24. In full wave rectification with a center tapped transformer, how many minimum diodes are required:

- (a) 2 (b) 3 (c) 4 (d) 1

25. If the frequency of A.C in half wave rectifier is "f" and period is T then after rectification the product of rectified signal's frequency & period is:

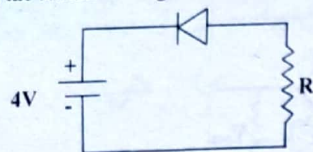
- (a)  $\frac{1}{2}$  (b)  $\frac{1}{4}$  (c) 2 (d) 1

26. A semiconducting device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current drops to almost zero. The device may be:

- (a) A p-n junction diode (b) An n-type semiconductor (c) A p-type semiconductor (d) An intrinsic semiconductor

Sr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Ans:	d	d	d	a	c	a	b	d	a	a		a	d	a

27. In figure, the current through the resistor is practically:



- (a) 5 A (b) 1 A (c) 2 A (d) Zero

28. A half-wave rectifier is being used to rectify an alternating voltage of frequency 50 Hz. The number of pulses of rectified current obtained in two seconds is

- (a) 50 (b) 100 (c) 25 (d) 200

29. Which device is used for conversion of A.C into D.C?

- (a) Transformer (b) OP-Amp  
(c) Semiconductor Diode (d) OR-Gate

30. Conversion of alternating current into direct current is called:

- (a) Amplification (b) Modulation (c) Rectification (d) None of these

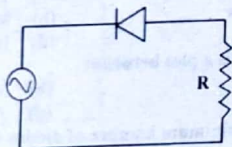
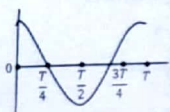
31. Output voltage of a rectifier is not smooth. It can be made smooth by using a circuit known as:

- (a) Wheat stone circuit (b) Ripple circuit  
(c) Bridge circuit (d) Filter circuit

32. In a half wave rectifier circuit, the ratio of resistance of diode during conduction half of A.C to its resistance during blocking half is of the order of:

- (a)  $1:10^6$  (b)  $1:10^3$  (c)  $10^6:1$  (d)  $10^3:1$

33. For the circuit shown:



Rectified output will be zero across resistor during \_\_\_\_\_, if the input A.C waveform is as following:

- (a)  $(0 \rightarrow \frac{T}{4} \text{ and } \frac{3T}{4} \rightarrow T)$  (b)  $(0 \rightarrow \frac{T}{2})$   
(c)  $(0 \rightarrow \frac{T}{4} \text{ and } \frac{T}{2} \rightarrow \frac{3T}{4})$  (d)  $(\frac{T}{4} \rightarrow \frac{3T}{4})$

34. Most useful type of rectification is/are:

- (a) Half wave rectification (b) Full wave rectification  
(c) Quarter waver rectification (d) Both A and B

35. In a half wave rectifier, when diode gets forward biased, the voltage across its terminals:

- (a) Becomes zero (b) Becomes equal to source voltage  
(c) Becomes equal to potential barrier (d) None of these

36. Ripple factor of half wave rectifier is

- (a) 1.21 (b) 0.8 (c) 0.6 (d) 0.4

37. Maximum efficiency of half wave rectifier is

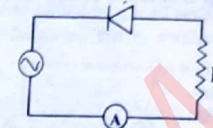
- (a) 80.6% (b) 40.60% (c) 70% (d) 50%

38. The output voltage of a rectifier is

- (a) Smooth (b) Pulsating (c) Perfectly direct (d) Alternating

Sr.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.
Ans:	d	b	c	c	d	a	d	b	a	a	b	b

39. What will be Ammeter reading in the circuit shown (during positive half of A.C)?



- (a) Positive maximum (b) Negative maximum  
(c) Zero (d) All of these

40. The potential drop across resistor in following circuit is:

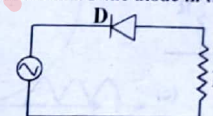


- (a) (6-0.7) V (b) 6 V (c) (6+0.7) V (d) Zero

41. In half wave rectifier, if the time period of input A.C is 50 ms, then the frequency of ripple at output in hertz is:

- (a) 50 (b) 30 (c) 20 (d) 40

42. During the negative half of A.C the diode in the circuit is:



- (a) Forward biased (b) open  
(c) Reverse biased (d) None of these

43. Which of the following output cannot be achieved by half wave rectifier circuit?

- (a) (b) (c) (d) All of these

44. The basic purpose of filter is to

- (a) Minimize variation in ac signal (b) Suppress harmonics in rectified output  
(c) Remove ripple from the rectified output (d) Stabilize dc output voltage

45. The bridge rectifier is preferred to an ordinary two diode full wave rectifier because

- (a) It needs much smaller transformer for the same output  
(b) No center tap required  
(c) Low PIV rating per diode  
(d) All of the above

46. Half wave rectifier uses

- (a) One diode (b) Two diode (c) Three diodes (d) Four diodes

47. A full wave rectifier passes \_\_\_\_\_ into positive cycles.

- (a) Lower half cycle (b) Upper half cycle  
(c) Both cycles (d) None of them

48. Half wave rectifier passes only:

- (a) Lower half cycle (b) Both cycles  
(c) Upper half cycle (d) Either lower or upper

Sr.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.
Ans:	c	a	c	a	b	c	d	a	c	d

49. In half wave rectification, the output DC voltage is obtained across the load for

- (a) The positive half cycle of input AC
- (b) The negative half cycle of input AC
- (c) The positive and negative half cycles of input AC
- (d) Either positive or negative half cycle of input

50. The maximum efficiency of full wave rectifier is

- (a) 80.60% (b) 40.60% (c) 70% (d) 50%

51. Peak voltage in the output of half wave rectifier is 10 V so dc component of output voltage is

- (a)  $10\sqrt{2}$  (b)  $\frac{10}{\sqrt{2}}$  (c)  $10/\pi$  (d)  $10\pi$

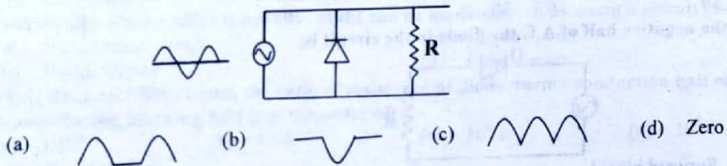
52. Ripple factor of full wave rectifier is

- (a) 1.21 (b) 0.6 (c) 0.482 (d) 0.9

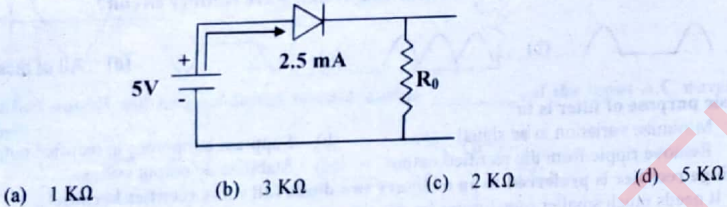
53. If any one diode of a full wave bridge rectifier is removed its output will become:

- (a) A.C (b) Half wave D.C (c) Smooth D.C (d) Zero

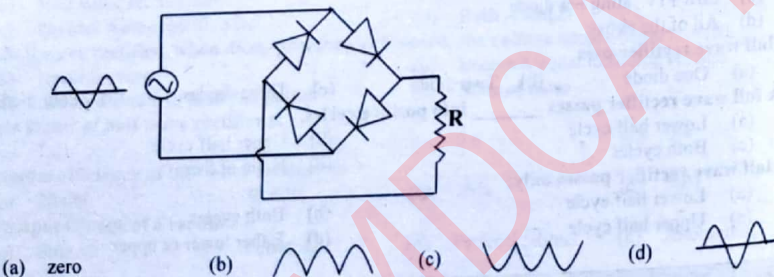
54. In the circuit shown, the figure below the output waveform will be:



55. If the diode resistance is negligible, the output resistance of following circuit  $R_0 = \dots\dots\dots$

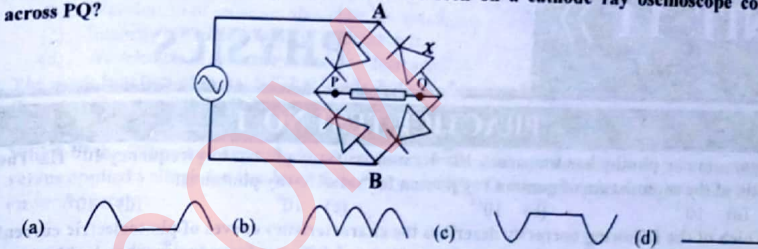


56. In the circuit output waveform is



Sr.	49.	50.	51.	52.	53.	54.	55.	56.
Ans:	d	a	c	c	c	a	c	a

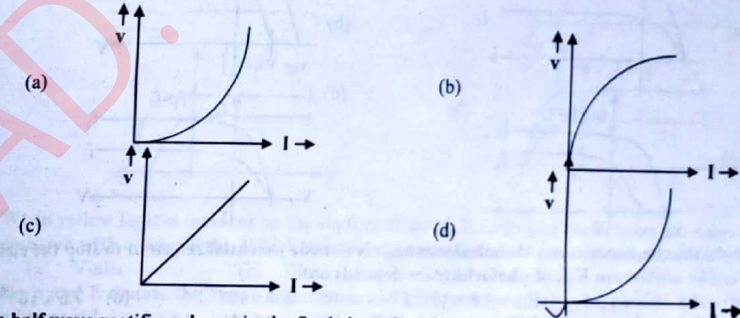
57. The circuit shows a bridge rectifier with a sinusoidal alternating voltage applied to it, the output terminals P and Q being joined by a load resistor. If diode X were removed leaving a break in the circuit, which of the following traces would be seen on a cathode ray oscilloscope connected across PQ?



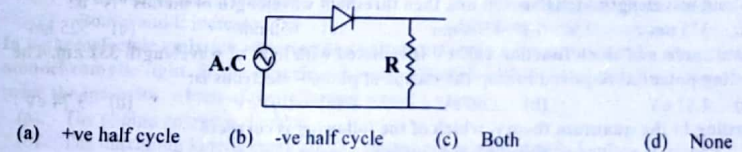
58. Which of the following is unidirectional device?

- (a) Resistor (b) Capacitor (c) Inductor (d) Diode

59. I-V graph for a diode is:



60. In half wave rectifier, shown in the fig. below, the diode will become as open circuit in:



Sr.	57.	58.	59.	60.
Ans:	a	d	b	a

## UNIT 11 &gt;&gt;

DAWN OF MODERN  
PHYSICS

## PRACTICE TEST NO. 1

- A gamma ray photon has frequency  $10^{22}$  Hz and an X-ray photon has frequency  $10^{18}$  Hz. The ratio of the momentum of gamma ray photon to that of X-ray photon is:
  - $10^{-4}$
  - $10^{-4}$
  - $10^6$
  - $10^{-6}$
- Which of the following correctly describes the characteristics curves of photoelectric current " $I_p$ " versus applied voltage for same intensities of light of different frequencies when incident on same metal:
 

(a)

(b)

(c)

(d)
- In a photoelectric experiment, the minimum negative anode potential required to stop the electron is 5V. The maximum K.E of photoelectrons depends on:
  - $8 \times 10^{-19}$  J
  - $4.8 \times 10^{-19}$  J
  - $6.4 \times 10^{-19}$  J
  - $7.6 \times 10^{-19}$  J
- The work functions of two different metals "N" and "O" are 3.2 eV and 1.6 eV respectively. If the threshold wavelength of "O" is 750 nm, then threshold wavelength of metals "N" is:
  - 375 nm
  - 1500 nm
  - 650 nm
  - 525 nm
- A metal surface of work function 1.07 eV is radiated with light of wavelength 332 nm. The retarding potential required to stop the escape of photo-electrons is:
  - 4.81 eV
  - 2.66 eV
  - 1.07 eV
  - 3.74 eV
- According to the quantum theory, which of the following is correct?
  - Energy is emitted or absorbed as a continuous wave
  - Radiation energy from a source is continuous rather than consisting of large number of tiny particles
  - Energy is emitted or absorbed in discrete packets
  - Intensity - wavelength curves obtained from a black body represent line spectrum
- If "E" is the energy of photon, "p" is its momentum, "f" is its frequency, " $\lambda$ " is its wavelength and "c" is its speed, Then which of the following relation is correct?
  - $E=pc$
  - $f = \frac{h}{pc}$
  - $\lambda = \frac{pc}{h}$
  - $p = \frac{hc}{\lambda}$
- The threshold wavelength for a metal show work function is 2 eV is:
  - 620 nm
  - 2480 nm
  - 1240 nm
  - 620 nm

Sr.	1.	2.	3.	4.	5.	6.	7.	8.
Ans:	c	b	a	a	b	c	a	a

- Photoelectrons are emitted by a metal when photons of wavelength 410 nm are incident. If the K.E of the emitted electrons is to be increased, then:
  - Intensity of radiation should be decreased
  - Wavelength of radiation should be increased
  - Intensity of radiation should be decreased
  - Wavelength of radiation should be decreased
- The work function of metal is 7.7 eV and photons of energy 22.5 eV are incident on metal surface, then stopping potential will be:
  - 14.8 V
  - 15 eV
  - 13.6 V
  - 14.8 eV
- Which of the following correctly describes the characteristic curves of photoelectric current " $I_p$ " versus applied voltage for two intensities " $I_1$ " and " $I_2$ " of a monochromatic light when incident on same metal:
 

(a)

(b)

(c)

(d)

- When yellow light is incident on the surface of metal, it emits photo-electrons but there is no such emission with orange light. Which one of these cannot produce emission of photoelectrons?
  - Violet
  - Blue
  - Red
  - Green
- Let p and E denote the linear momentum and energy respectively of a photon. If the wavelength is increased,
  - p decreases and E increases
  - p increases and E decreases
  - Both p and E increase
  - Both p and E decreases
- In a photoelectric emission experiment a metal surface in an evacuated tube was illuminated with monochromatic light. If the experiment were repeated with light of the same wavelength, but of twice the intensity, which of the following would be true?
  - The photon energy is doubled
  - The maximum kinetic energy of the ejected electrons is doubled
  - The work function of the metal becomes halved
  - The photocurrent is doubled
- Dual nature of radiation is shown by:
  - Diffraction and interference
  - Refraction and diffraction
  - Photoelectric effect alone
  - Photoelectric effect and diffraction
- When the frequency of the incident light is equal to or greater than the threshold value then there will be:
  - Spontaneous emission of photoelectrons
  - Thermionic emission of photoelectrons
  - Simulated emission of photoelectrons
  - Induced emission of photoelectron
- Compton's shift in wavelength ( $\Delta\lambda$ ) is zero, when scattered angle of photon is:
  - $90^\circ$
  - $180^\circ$
  - $0^\circ$
  - $45^\circ$

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Ans:	d	a	d	c	d	d	d	a	c

18. A device that converts light energy into electrical energy is called:  
(a) Transformer (b) Semiconductor diode (c) Photocell (d) Thermistor
19. A process in which a high energy gamma ray photon disappears by producing an electron and a positron when it passes close to heavy nucleus is called:  
(a) Photoelectric effect (b) Pair annihilation  
(c) Compton's effect (d) Pair production
20. If the wavelength of incident radiation in a photoelectric experiment is decreased from 6000 Å to 4000 Å, then:  
(a) The photoelectric current may stop (b) The stopping potential will decrease  
(c) The photoelectric current will increase (d) The stopping potential will increase
21. The minimum frequency of incident light required to emit photoelectrons from the metal surface is called:  
(a) Critical frequency (b) Intermediate frequency  
(c) Work function (d) Threshold frequency
22. A photon of energy 3.4 eV is incident on a metal having work function 2.3 eV. The maximum K.E of photo-electrons is equal to:  
(a) 1.4 eV (b) 1.1 eV (c) 1.7 eV (d) 4.4 eV
23. Which of the following has greatest energy content?  
(a) 50 photons of green light (b) 50 photons of yellow light  
(c) 50 photons of orange light (d) 50 photons of blue light
24. Arthur Holy Compton found that scattered wavelength " $\lambda_s$ " has a relation with incident wavelength " $\lambda_i$ " as:  
(a)  $\lambda_s < \lambda_i$  (b)  $\lambda_s = \lambda_i$  (c)  $\lambda_s > \lambda_i$  (d)  $\lambda_s \leq \lambda_i$
25. The converse effect of pair production is:  
(a) Compton effect (b) Photoelectric effect  
(c) X-ray production (d) Annihilation of matter
26. The photon is the particle, which has:  
(a) Infinite rest mass (b) Rest mass but no charge  
(c) No rest mass & no charge (d) A & C are correct
27. Energy of photon is directly proportional to its:  
(a) Temperature (b) Wave length (c) Frequency (d) Intensity
28. Wave theory of light is unable to prove  
(a) Black body radiation (b) Photoelectric effect  
(c) Compton effect (d) All of them
29. If a photon is absorbed by an electron the energy of electron  
(a) Increase (b) Decrease  
(c) Remain same (d) Another photon will be released by electron
30. Which among the following phenomenon shows particle nature of light?  
(a) Photoelectric effect (b) Interference  
(c) Polarization (d) Matter waves
31. The value of Rydberg constant varies with atomic number as:  
(a)  $Z^3$  (b)  $1/Z^2$  (c)  $Z^2$  (d)  $Z$
32. Wave nature and particle nature of photon is linked by  
(a) Rest mass of photon (b) Wavelength of photon  
(c) Light speed (d) Momentum of photon
33. Planck constant is named after  
(a) Einstein (b) Newton's (c) Maxwell (d) None of these

Sr.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
Ans:	c	d	d	d	b	d	c	d	c	c	d	a	a	c	b	c

34. Numbers of electrons emitted in photoelectric effect depends upon  
(a) Wavelength of incident light (b) Frequency of incident light  
(c) Energy of incident light (d) Intensity of incident light
35. In annihilation process photons move in  
(a) Same direction (b) Opposite direction  
(c) Perpendicular direction (d) None of these
36. Rest mass of photon is equal to:  
(a) Zero (b)  $Mv$  (c)  $h/\lambda$  (d)  $\lambda/h$
37. Compton wavelength is:  
(a)  $2.43 \mu\text{m}$  (b)  $2.43 \text{ m}$  (c)  $2.43 \text{ pm}$  (d)  $243 \text{ nm}$
38. In a photoelectric experiment a light beam of frequency greater than threshold frequency is incident on a metal. If the work function of metal is 4.2 eV and stopping potential for incident light is 5.7 V then the energy of incident photon is:  
(a) 9.9 eV (b) 1.5 eV (c) 5 eV (d) Cannot be predicted
39. The photocurrent in an experiment on photoelectric effect decreases if:  
(a) The intensity of the source is increased (b) The exposure time is increased  
(c) The intensity of the source is decreased (d) The exposure time is decreased
40. Which phenomenon does not verify the particle nature of light:  
(a) Photoelectric effect (b) Compton's effect  
(c) Pair production (d) Diffraction
41. Which of the following has greatest energy content?  
(a) 20 photons of red-light (b) 20 photons of green light  
(c) 20 photons of orange light (d) 20 photons of yellow light
42. A source of light is placed at a distance of 100 cm from a photocell and stopping potential is found to be  $V_0$ . If the distance is double, the stopping potential will be:  
(a)  $2V_0$  (b)  $V_0$  (c)  $\frac{V_0}{4}$  (d)  $\frac{V_0}{2}$
43. In a photoelectric experiment, the wavelength of incident radiation is reduced from 300 Å to 2000 Å, then:  
(a) Work function of metal will increase (b) Threshold frequency will decrease  
(c) K.E of emitted electron will decrease (d) Stopping potential will increase
44. Which of the following is true about the photoelectric effect?  
(a) Energy of photoelectrons is directly proportional to intensity of photons  
(b) Photoelectrons are not emitted below a certain minimum intensity of photons  
(c) Number of photoelectrons emitted per second is independent of intensity of incident radiation  
(d) For a given metal there is a minimum frequency of light below which no emission occurs
45. According to Einstein's photoelectric equation, the graph of K.E of photoelectrons emitted from a metal versus the frequency of incident photons is a straight line whose slope:  
(a) Depends on intensity of incident photons  
(b) Depends on frequency of incident photons  
(c) Depends on nature of metal used  
(d) Is same for all metals irrespective of frequency and intensity of incident photons
46. Which of the following statement is correct about infrared radiation and X-rays.  
(a) Radio waves has frequency larger than X-rays but less than infrared waves  
(b) Infrared radiation travels faster than X-rays in vacuum  
(c) Infrared radiation has lower frequency than X-rays  
(d) Infrared waves cannot be diffracted like X-rays

Sr.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	d	b	a	c	a	c	d	b	b	c	d	d	c

47. The threshold frequency of a metal is  $3 \times 10^{14}$  Hz. The work function for the metal is:

- (a)  $1 \times 10^{-20}$  J (b)  $4.8 \times 10^{-19}$  J (c)  $2 \times 10^{-19}$  J (d)  $2.7 \times 10^{-19}$  J

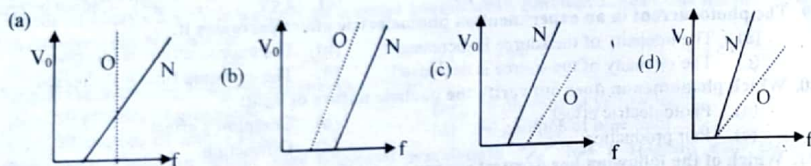
48. The photoelectric threshold for a metal is 300 nm. If the metal is illuminated with radiation of 400 nm, then the maximum K.E of emitted electrons is:

- (a) 1.5 eV (b) 3.3 eV (c) 4.2 eV (d) There is no photo emission

49. A metal "N" is illuminated by ultraviolet and visible radiation successively and stopping potential is measured. This stopping potential is:

- (a) More with visible light (b) More with ultraviolet light  
(c) Equal in both cases (d) May A or B

50. In a photoelectric experiment, electrons are ejected from metals "N" and "O" by light of frequency  $f$ . The stopping potential " $V_0$ " is measured for various frequencies. If "O" has greater work function than "N", which graph illustrates the expected result?



Sr.	47.	48.	49.	50.
Ans:	c	d	b	b

## PRACTICE TEST NO. 2

1. The proton and antiproton collision will result:

- (a) Scattering (b) Repulsion (c) Attraction (d) Annihilation

2. Which particle has dual nature?

- (a) Photon (b) Alpha (c) Electron (d) All of these

3. Which group consists of only electromagnetic waves:

- (a) Microwaves, radio waves, infrared (b) Microwaves, radio waves, sound  
(c) Microwaves, water waves, infrared (d) None of these

4. Einstein was awarded Nobel Prize for his work on:

- (a) Photoelectric effect (b) Nuclear fission  
(c) Theory of relativity (d) All are correct

5. Existence of photon was confirmed by:

- (a) Compton (b) De-broglie (c) Einstein (d) Max plank

6. The speed of photons in vacuum is \_\_\_\_\_ than in liquid water:

- (a) Higher (b) Smaller (c) Equal (d) None of these

7. What is the energy of a photon in a beam of infrared radiation of wavelength 1240 nm?

- (a) 1 (b)  $6.25 \times 10^{-18}$  (c)  $1.6 \times 10^{-19}$  (d)  $3.6 \times 10^{-6}$

8. The momentum of the moving photon is:

- (a) Zero (b)  $\lambda/h$  (c)  $h\lambda$  (d)  $h/\lambda$

9. Which light photon has the least momentum

- (a) Red (b) Green (c) Yellow (d) Blue

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Ans:	d	d	a	a	c	a	c	d	a

10. The frequency of the incident photon after Compton effect will

- (a) Remain constant (b) Increases (c) Decreases (d) None of these

11. In Compton's scattering the change in the wavelength is given by:

- (a)  $\Delta\lambda = \frac{h}{m_0 c^2} (1 + \cos \theta)$  (b)  $\Delta\lambda = \frac{h}{m_0 c^2} (1 - \cos \theta)$   
(c)  $\Delta\lambda = \frac{h}{m_0 c} (1 - \cos \theta)$  (d)  $\Delta\lambda = \frac{h}{m_0 c} (1 + \cos \theta)$

12. The change in the wavelength in Compton's effect can be explained on the basis of:

- (a) Classical theory (b) Quantum theory  
(c) Energy band theory (d) Wave theory

13. According to the quantum theory, which of the following is correct?

- (a) Energy is emitted or absorbed as a continuous wave  
(b) Intensity-wavelength curves obtained from a black body represent line spectrum  
(c) Energy is emitted or absorbed in discrete packets  
(d) Radiation energy from a source is continuous rather than consisting of large number of tiny particles

14. If a surface has work function of 3.00 eV, the longest wavelength of light which will cause the emission of electrons is:

- (a)  $4.876 \times 10^{-7}$  m (b)  $4.125 \times 10^{-7}$  m (c)  $5.998 \times 10^{-7}$  m (d)  $6.847 \times 10^{-7}$  m

15. The work function of tungsten 4.5 eV. The threshold frequency is:

- (a)  $1.09 \times 10^{15}$  Hz (b)  $1.09 \times 10^{15}$  Hz (c)  $0.91 \times 10^{15}$  Hz (d)  $1 \times 10^{16}$  Hz

16. Photoelectric effect shows;

- (a) Wave-like behavior of light  
(b) Particle-like behavior of light  
(c) Both wave-like and particle-like behavior of light  
(d) None of these

17. Photoelectric effect is the phenomenon in which:

- (a) Photons come out of metal when it is hit by a beam of electrons  
(b) Photons come out of nucleus of an atom under the action of an electric field  
(c) Electrons come out of a metal with constant velocity  
(d) Electrons come out of a metal with different velocities not greater than a certain value

18. According to particle model of light, a photon travels with speed equal to:

- (a)  $3 \times 10^6$  m s<sup>-1</sup> (b)  $3 \times 10^7$  m s<sup>-1</sup> (c)  $3 \times 10$  m s<sup>-1</sup> (d)  $3 \times 10^8$  m s<sup>-1</sup>

19. The time of photoelectron emission is usually:

- (a) Less than nano-second (b) Equal to one micro-second  
(c) Greater than nano-second (d) Equal to one milli-second

20. Compton shift in the wavelength of photon when it scattered at angle  $60^\circ$  is:

- (a)  $\frac{h}{m_0 c}$  (b)  $\frac{3h}{2m_0 c}$  (c)  $\frac{h}{2m_0 c}$  (d)  $\frac{4h}{3m_0 c}$

21. The particle nature of electromagnetic radiation is suggested by experiments on:

- (a) The interference experiment  
(b) Compton's effect  
(c) The electron diffraction experiment  
(d) The scattering of X-rays by crystalline materials

22. Compton's effect is mainly associated with:

- (a) Gamma rays (b) X-rays (c) Beta rays (d) Positive rays

23. The photon is a radio wave of wavelength  $3 \times 10^8$  cm have an energy:

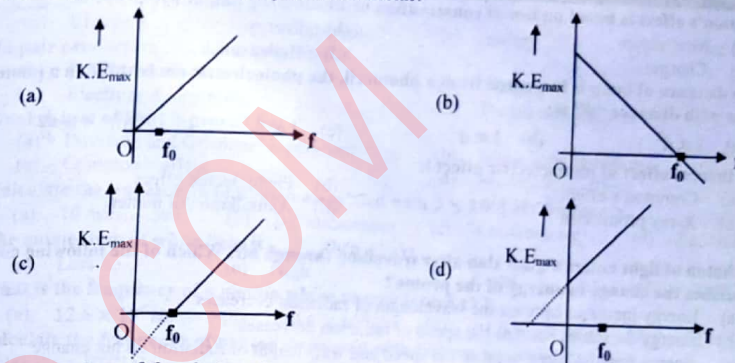
- (a)  $6.63 \times 10^{-32}$  J (b)  $6.63 \times 10^{-28}$  J (c)  $6.63 \times 10^{-30}$  J (d)  $6.63 \times 10^{-30}$  J

Sr.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Ans:	c	d	b	c	b	a	b	d	d	a	c	b	b	a

24. A gamma ray photon has frequency  $5 \times 10^{22}$  Hz and an X-ray photon has frequency  $2 \times 10^{18}$  Hz. The ratio of the momentum of X-ray photon to that of gamma-ray photon is:  
 (a)  $4 \times 10^{-5}$  (b)  $4 \times 10^4$   
 (c)  $2.5 \times 10^4$  (d)  $4 \times 10^5$
25. Stopping potential depends:  
 (a) Only upon the energy of incident photon  
 (b) Only on the work function of the metal  
 (c) On the difference in energy of incident photon and work function of metal  
 (d) On the sum of energy of incident photon and work function of metal
26. The energy of a photon is  $9 \times 10^{-19}$  J. Its momentum is:  
 (a)  $10^{-27}$  kg ms<sup>-1</sup> (b)  $10^{-11}$  kg ms<sup>-1</sup>  
 (c)  $9.10 \times 10^{-11}$  kg ms<sup>-1</sup> (d)  $3 \times 10^{-27}$  kg ms<sup>-1</sup>
27. Which of the following is correct descending order of wavelength of given electromagnetic radiation?  
 (a) Microwaves, short radio waves, infrared  
 (b) x-rays, visible, microwaves  
 (c) Long radio waves, infrared, ultraviolet  
 (d) Ultraviolet, gamma rays, X-rays
28. Visible region of electromagnetic radiation spectrum ranges:  
 (a) From 350 nm to 800 nm (b) From 400 nm to 600 nm  
 (c) From 400 nm to 750 nm (d) From 500 nm to 700 nm
29. Which photon, red, green, indigo or orange carries the least momentum?  
 (a) Red (b) Indigo (c) Orange (d) Green
30. Which of the following is correct about photoelectric effect?  
 (a) Electrons are emitted if frequency of incident photons is below a critical value  
 (b) Electrons are emitted if wavelength is more than a critical value  
 (c) Speed of photoelectrons is inversely proportional to work function  
 (d) K.E of photoelectrons is directly proportional to intensity incident photon beam
31. Photoelectric effect is based on law of conservation of:  
 (a) Charge (b) Angular momentum (c) Momentum (d) Energy
32. Photoelectrons are emitted by a metal surface only when the light incident on it:  
 (a) Has wavelength greater than a certain minimum wavelength  
 (b) Has frequency less than or equal to certain maximum frequency  
 (c) Has wavelength less than or equal to certain maximum wavelength  
 (d) May A or C
33. The maximum speed of photoelectrons depends on:  
 (a) Threshold frequency of cathode (b) Frequency of incident light  
 (c) Work function (d) All of these
34. In a photoelectric experiment, the wavelength of incident light is increased. Which of the following is the effect of this change on the K.E of emitted electrons?  
 (a) Average K.E increases (b) Minimum K.E decreases  
 (c) Maximum K.E increases (d) Average K.E decreases
35. Which phenomena cannot be explained wave theory of light?  
 (a) Diffraction (b) Interference (c) Polarization (d) Photoelectric effect
36. A photon of energy 3.4 eV is incident on a metal having work function 2 eV. The maximum K.E of photo-electrons is equal to:  
 (a) 1.4 eV (b) 1.7 eV (c) 5.4 eV (d) 6.8 eV

Sr.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.
Ans:	a	c	d	c	c	a	c	d	c	d	d	d	a

37. Which of the following correctly describe the relation between maximum K.E of photoelectrons versus light frequency for a perpendicular metal?



38. The momentum of the photon of wavelength  $3000 \text{ \AA}$  will be:  
 (a)  $1.3 \times 10^{-27}$  kg ms<sup>-1</sup> (b)  $2.2 \times 10^{-27}$  kg ms<sup>-1</sup>  
 (c)  $1.3 \times 10^{-28}$  kg ms<sup>-1</sup> (d)  $2.2 \times 10^{-28}$  kg ms<sup>-1</sup>
39. The correct relation out of following:  
 (a)  $\frac{h\lambda}{c} = E$  (b)  $h\lambda = \frac{E}{c}$  (c)  $\frac{hc}{E} = \lambda$  (d) None of these
40. Which photon, red, green, indigo or orange carries the most energy?  
 (a) Indigo (b) Orange (c) Green (d) Blue
41. Light of frequency 1.5 times the threshold frequency is incident on a photo sensitive surface. If the frequency is halved, the photoelectric current is:  
 (a) Doubled (b) Halved (c) Same (d) Reduce to zero
42. A metal surface ejects electrons when incident by blue light but no electron when incident by green light. The electrons will be ejected when the surface is incident by:  
 (a) Violet light (b) Red light (c) Yellow light (d) Orange light
43. Two photons have wavelength 650 nm and 1300 nm. The ratio of their respective frequencies is:  
 (a) 4:1 (b) 1:1 (c) 1:2 (d) 2:1
44. The momentum of a photon of wavelength  $100 \text{ \AA}$  is:  
 (a)  $6.63 \times 10^{-26}$  Ns (b)  $6.63 \times 10^{-22}$  Ns (c)  $6.63 \times 10^{-21}$  Ns (d)  $6.63 \times 10^{-28}$  Ns
45. Photons of energy 6.2 eV are incident on a metal whose work function is 4.2 eV. The K.E of the fastest electrons emitted in joules is:  
 (a)  $6.8 \times 10^{-19}$  (b)  $4.8 \times 10^{-19}$  (c)  $1.6 \times 10^{-19}$  (d)  $3.2 \times 10^{-19}$
46. The frequency of photon of energy 4 eV is of the order of:  
 (a)  $10^{15}$  Hz (b)  $10^{11}$  Hz (c)  $10^{21}$  Hz (d)  $10^{18}$  Hz
47. The work function of a metal is 3.3 eV. The threshold frequency of that metal will be:  
 (a)  $8 \times 10^{14}$  Hz (b)  $2 \times 10^{20}$  Hz (c)  $4 \times 10^{14}$  Hz (d)  $5 \times 10^{20}$  Hz
48. The work function for potassium and sodium respectively:  
 (a) 2.3 eV, 2.7 eV (b) 5.1 eV, 2.3 eV (c) 4.7 eV, 4.3 eV (d) 5 eV, 4.8 eV
49. According to particle model of light, a photon is electrically:  
 (a) Neutral (b) Positively charged (c) Charged (d) Negatively charged
50. Invisible region of electromagnetic radiation spectrum lies below:  
 (a) 450 nm (b) 400 nm (c) 500 nm (d) 600 nm

Sr.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	b	c	a	d	a	d	a	d	a	a	a	a	b

## PRACTICE TEST NO. 3

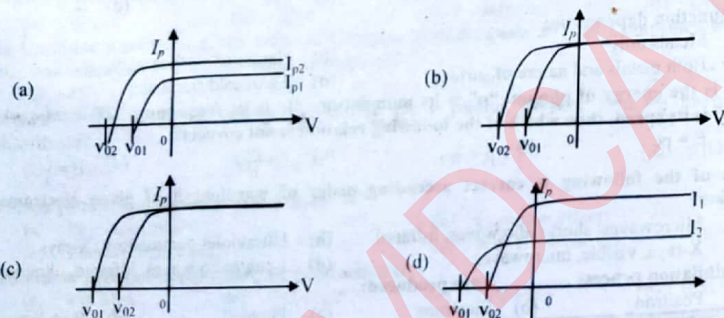
- Compton's effect is based on law of conservation of:
  - Momentum
  - Energy
  - Charge
  - Both a and b
- If the distance of lamp is increased from a photocell, the photoelectric current "I" in a photo cell varies with distance "d" as:
  - $I \propto d^2$
  - $I \propto d$
  - $I \propto \frac{1}{d}$
  - $I \propto \frac{1}{d^2}$
- The inverse effect of photoelectric effect is:
  - Compton's effect
  - Photoelectric effect
  - X-ray production
  - Annihilation of matter
- A photon of light enters a glass slab after travelling through air. Which of the following correctly describes the change in energy of the photon?
  - Energy increases because the wavelength of radiation decreases
  - Energy decreases because the speed of radiation decreases
  - Energy remains same because the speed and wavelength of radiation do not change
  - Energy remains same because the frequency of radiation remains same
- Electrons are emitted when a beam of red light falls on cathode of photocell. If the red light beam is replaced by a blue light beam of same power, which of the following quantity would decrease?
  - Work function of cathode
  - Maximum K.E of electrons emitted
  - Energy of each photon striking the cathode
  - Number of photons striking the cathode per unit time
- In order to increase the kinetic energy of ejected photoelectrons:
  - The intensity of radiation should be increased
  - The wavelength of radiation should be increased
  - The frequency of radiation should be increased
  - Both wavelength and intensity of radiation should be increased
- Given  $h = 6.6 \times 10^{-34}$  J s. The momentum of each photon is given radiation is  $3.3 \times 10^{-29}$  kg ms<sup>-1</sup>. The frequency of radiation is:
  - $3 \times 10$  Hz
  - $6 \times 10^{10}$  Hz
  - $7.5 \times 10^{12}$  Hz
  - $1.5 \times 10^{13}$  Hz
- Four elements A, B, C, D have work functions 2.2, 4.2, 8.3, 2 eV. Light of wave length 4000 Å is incident on them. The elements which emit photo electrons are:
  - A, B, C, D
  - A, B
  - A, B, C
  - A
- Which photon violet, blue, green, infrared or orange carries the most momentum?
  - Violet
  - Blue
  - Infrared
  - Green
- In Compton's scattering, the value of Compton's shift equals 30% of Compton's wavelength of electron when X-ray is scattered at an angle of:
  - 45°
  - 30°
  - 60°
  - 90°
- Which of the following is correct relation for a photon (Where symbols have their usual meanings)?
  - $\lambda \propto \frac{1}{E}$
  - $\lambda \propto \frac{1}{f}$
  - $\lambda \propto \frac{1}{p}$
  - All of these
- X-rays production is the reverse process of
  - Pair production
  - Compton effect
  - Photoelectric effect
  - A & B are correct
- Minimum energy required for pair production is:
  - 939 MeV
  - 942 MeV
  - 1.02 MeV
  - 0.511 MeV

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Ans:	d	d	c	d	d	c	d	c	a	a	d	c	c

- If Alpha, beta, and gamma rays carry the same momentum, which has the longest wavelength?
  - Alpha rays
  - Beta rays
  - Gamma rays
  - All have same wavelength
- \_\_\_\_\_ is conserved in pair production
  - Charge
  - Momentum
  - energy
  - None of these
- In pair production ..... are produced:
  - Positron & electron
  - Photons
  - Electrons & neutron
  - Proton and electron
- Dual nature of light is proved by:
  - Davission and Germans' experiment
  - Black body radiation
  - Compton's effect
  - Photoelectric effect
- Calculate the wavelength of photon associated with  $3 \times 10^{14}$  Hz frequency.
  - 10 micrometer
  - 100 micrometer
  - 1 micrometer
  - 2 micrometer
- The momentum of white light is \_\_\_\_\_ then x rays
  - Less
  - High
  - Equal
  - None of these
- What is the frequency of a photon whose energy is 66.3 eV?
  - $12.6 \times 10^6$  Hz
  - $19.6 \times 10^6$  Hz
  - $1.6 \times 10^{16}$  Hz
  - $81 \times 10^{16}$  Hz
- Calculate the frequency of photon associated with 500 nm wavelength:
  - $5 \times 10^{14}$  Hz
  - $6 \times 10^{14}$  Hz
  - $7 \times 10^{14}$  Hz
  - $9 \times 10^{14}$  Hz
- Joule – second is the unit of:
  - Energy
  - Heat
  - Work
  - Planck's constant
- The spectrum of white light lies:
  - Above 300 nm
  - Below 300 nm
  - In between UV to IR
  - None of these
- The photon when scattered from mirror its momentum becomes
  - Double
  - Half
  - Remain same
  - Zero
- The concept of work function was given by
  - Bohr
  - Einstein
  - Rutherford
  - None of these
- In annihilation process ..... are produced:
  - Positron
  - Electrons
  - Photons
  - Both b & c
- The existence of positron was discovered in the
  - Thermal radiation
  - Cosmic radiation
  - Electromagnetic radiation
  - Non electromagnetic radiation
- Momentum of a photon is
  - 0
  - $\frac{hc}{\lambda}$
  - $\frac{hf}{c}$
  - $\frac{E}{\lambda}$
- Work function depends on:
  - Metals only
  - Nature of surface only
  - Both metals and nature of surface
  - Threshold frequency
- If "E" is the energy of photon, "p" is its momentum, "f" is its frequency, "λ" is its wavelength and "c" is its speed, then which of the following relation is not correct?
  - $E = pc$
  - $p = \frac{h}{\lambda}$
  - $f = \frac{pc}{h}$
  - $E = \frac{h}{\lambda}$
- Which of the following is correct ascending order of wavelength of given electromagnetic radiation?
  - Microwaves, short radio waves, infrared
  - Ultraviolet gamma rays, X-rays
  - X-rays, visible, microwaves
  - Long radio waves, infrared, ultraviolet
- In annihilation process ..... are produced:
  - Positron
  - Electrons
  - Photons
  - Both b & c

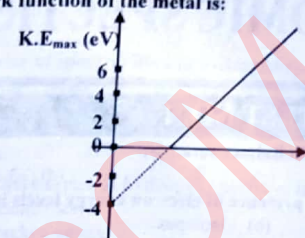
Sr.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.
Ans:	d	d	a	a	c	a	c	b	d	c	c	b	c	b	c	c	d	c	c

33. Lights of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively, successively illuminate a metal of work function 0.5 eV. The ratio of maximum speeds of the emitted electrons will be:  
 (a) 1:5 (b) 1:4 (c) 1:3 (d)  $1:\sqrt{3}$
34. What energy (in joules) would a photon of light with a wave length  $3 \times 10^{-4}$  cm have:  
 (a)  $2.2 \times 10^{-44}$  (b)  $3.3 \times 10^{-21}$  (c)  $6.6 \times 10^{-20}$  (d)  $6.6 \times 10^{-48}$
35. Which of the following is dependent on the frequency of incident radiation in a photoelectric experiment?  
 (a) Amount of photoelectric current  
 (b) Stopping potential to reduce the photoelectric current to zero  
 (c) Work function of the metal used in the experiment  
 (d) Threshold wavelength
36. In Compton's effect if  $f$  is frequency of incident photon and  $f'$  is frequency of scattered photon, then which of the following is true?  
 (a)  $f' = f$  (b)  $f' \geq f$  (c)  $f' \leq f$  (d)  $f' < f$
37. A photocell is based on the principle of:  
 (a) Photoelectric effect (b) Pair production  
 (c) Compton effect (d) Annihilation of matter
38. The work function of tungsten is 4.5 eV. The threshold frequency is:  
 (a)  $1.09 \times 10^{15}$  Hz (b)  $0.91 \times 10^{15}$  Hz (c)  $1.09 \times 10^{15}$  Hz (d)  $1 \times 10^{16}$  Hz
39. What is the energy of photon in a beam of infrared radiation of wavelength 1240 nm?  
 (a) 1 eV (b) 3 eV (c) 4 eV (d) 2 eV
40. A beam of red light, a beam of yellow light, a beam of green light and a beam of blue light have exactly the same energy. Which beam contains the greatest number of photons and which beam contains the smallest number of photons?  
 (a) Green, blue (b) Blue, yellow (c) Red, blue (d) Yellow, red
41. If ' $m$ ' is the mass, ' $c$ ' is the velocity of light and  $x = mc^2$ , then dimensions of ' $x$ ' will be:  
 (a)  $[LT^{-1}]$  (b)  $[MLT^{-1}]$  (c)  $[ML^2T^{-2}]$  (d)  $[MLT^{-2}]$
42. Which of the following has greatest energy content?  
 (a) 10 photons of yellow light (b) 10 photons of blue light  
 (c) 10 photons of violet light (d) 10 photons of red light
43. Two light beams of same intensities and same energies are incident on two different metals with work functions " $\Phi_2 = 2\Phi_1$ ". Which of the following correctly describes the characteristic curves of photoelectric currents versus applied voltage for given two metals:



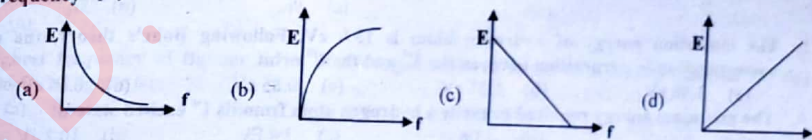
Sr.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.
Ans:	d	c	b	d	a	a	a	c	c	c	d

44. The graph between maximum K.E of photoelectrons versus frequency of incident photon on a metal surface is shown as:  
 The work function of the metal is:

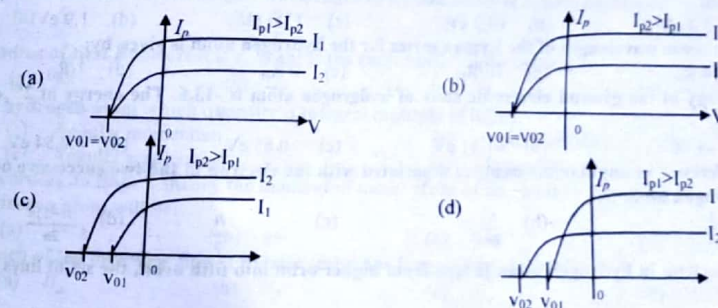


- (a) 1.5 eV (b) 4 eV (c) 3.0 eV (d) Can't be predicted

45. Which of the following graph shows the variation of energy " $E$ " of a photon of light with its frequency " $f$ "?



46. Two light beams of intensities " $I_1$ " and " $I_2$ " such that  $I_1 > I_2$  but both beam have same energies are following correctly describes the characteristic curves of photoelectric current ( $I_{p1}$ ,  $I_{p2}$ ) versus, applied voltage for the given two metals:



47. Plank's constant has same units as that of:  
 (a) Pressure (b) Power (c) Momentum (d) Angular momentum
48. Speed of zero rest mass particle in free space is:  
 (a) Zero (b) Infinite (c)  $3 \times 10^8$  m/s (d) 332 m/s
49. The ratio of energy photon to momentum of photon is equal to:  
 (a) Speed (b) Wavelength (c) Frequency (d) None of these
50.  $\text{Kgm}^2\text{s}^{-1}$  is unit of constant:  
 (a) Plank's (b) Rhydberg (c) Boltzmann (d) General gas constant

Sr.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	d	a	d	c	a	a

## UNIT 12 &gt;&gt;

## ATOMIC SPECTRA

## PRACTICE TEST NO. 1

- The ratio of minimum to maximum wavelength in Balmer series is:
  - 5 : 9
  - 5 : 36
  - 1 : 4
  - 3 : 34
- Which of the following phenomena suggests the presence of electron energy levels in atoms:
  - Radio active decay
  - Isotopes
  - Spectral lines
  - $\alpha$ -particle scattering
- The energy of electron in first excited state of H-atom is -3.4 eV its kinetic energy is:
  - 3.4 eV
  - +3.4 eV
  - 6.8 eV
  - 6.8 eV
- In Bohr's model, the atomic radius of the first orbit is  $r_0$ , then the radius of the third orbit is:
  - $\frac{r_0}{9}$
  - $r_0$
  - $9r_0$
  - $3r_0$
- The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between the 3<sup>rd</sup> and the 4<sup>th</sup> orbit
  - 3.40 eV
  - 1.51 eV
  - 0.85 eV
  - 0.66 eV
- The minimum energy required to excite a hydrogen atom from its 1<sup>st</sup> excited state is:
  - 13.6 eV
  - 13.6 eV
  - 3.4 eV
  - 10.2 eV
- The angular momentum of electron in  $n$  orbit is given by:
  - $nh$
  - $\frac{h}{2}$
  - $n \frac{h}{2\pi}$
  - $n^2 \frac{h}{2\pi}$
- When electron jumps from the first excited state to ground state, the emitted photon will have energy of:
  - 3.4 eV
  - 10.2 eV
  - 13.6 eV
  - 1.9 eV
- The minimum wavelength of the Lyman series for the hydrogen atom is given by:
  - $4/R_H$
  - $16/R_H$
  - $9/R_H$
  - $1/R_H$
- The energy of the ground electronic state of hydrogen atom is -13.6. The energy of 2<sup>nd</sup> excited state is:
  - 3.40 eV
  - 1.51 eV
  - 0.85 eV
  - 0.54 eV
- The difference in angular momentum associated with the electron in the two successive orbits of the hydrogen atom is:
  - $\frac{h}{\pi}$
  - $\frac{h}{2\pi}$
  - $\frac{h}{2}$
  - $\frac{(n-1)h}{2\pi}$
- When electron in hydrogen atom jumps from higher orbit into fifth orbit, the set of lines emitted is called:
  - Lyman series
  - Pfund series
  - Balmer series
  - Paschen series
- The Balmer series were identified in the spectrum of hydrogen by:
  - Einstein
  - Compton
  - Max planks
  - J.J. Balmer
- The speed of electron in the  $n$ th orbit  $v_n$  of hydrogen atom is related to principal quantum number  $n$  as:
  - $v_n \propto \frac{1}{n}$
  - $v_n \propto \frac{1}{n^2}$
  - $v_n \propto n$
  - $v_n \propto \frac{1}{n^3}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	a	c	b	c	d	d	b	b	d	b	b	b	d	a

- The shortest wavelength of spectral line in Balmer of Hydrogen atom is:
  - $R_H$
  - $1/R_H$
  - 0
  - $4/R_H$
- If  $r_1$  is the radius of first quantized orbit of hydrogen atom, then radius of 4<sup>th</sup> quantized orbit is:
  - $4r_1$
  - $16r_1$
  - $8r_1$
  - $32r_1$
- Which series of spectral lines in hydrogen spectrum does not lie in the infra-red region?
  - Pfund series
  - Paschen series
  - Balmer series
  - Brackett series
- To find longest wavelength in Paschen series of hydrogen spectrum, the value of  $n$  is taken equal to:
  - 3
  - 5
  - 4
  - 6
- Which of these series of hydrogen spectrum lies in the ultra-violet region?
  - Paschen series
  - Pfund series
  - Brackett series
  - Lyman series
- The ratio of energies of first two excited states of hydrogen atom is:
  - 4
  - $\frac{3}{2}$
  - $\frac{1}{4}$
  - $\frac{2}{4}$
- The velocity of electron in the second orbit of hydrogen atom is  $v$ . The velocity of electron in fifth orbit will be:
  - $V$
  - $\frac{5}{2}V$
  - $\frac{22}{5}V$
  - $\frac{2}{5}V$
- Highest frequency of Balmer series of hydrogen atom in terms of Rydberg constant  $R_H$  and velocity of light  $c$  is:
  - $R_H c$
  - $\frac{4}{R_H c}$
  - $4R_H c$
  - $\frac{R_H c}{4}$
- When hydrogen atom is in first excited state; Its radius is how many times of its ground state radius?
  - Half
  - Twice
  - Four times
  - Same as that of ground state
- The ratio of shortest to longest wavelength of Lyman series is approximately:
  - $\frac{4}{1}$
  - $\frac{9}{5}$
  - $\frac{9}{4}$
  - $\frac{3}{4}$
- Radius of first Bohr orbit is  $r$ . What is the radius of 2<sup>nd</sup> Bohr orbit?
  - $8r$
  - $2r$
  - $4r$
  - $2\sqrt{2}r$
- In hydrogen atom which quantity is integral multiple of  $h/2\pi$ :
  - Angular momentum
  - Angular velocity
  - Angular acceleration
  - Momentum
- According to Bohr's theory the moment of momentum of an electron revolving in second orbit of hydrogen atom will be:
  - $2 = h$
  - $\pi h$
  - $h/\pi$
  - $2h/\pi$
- Which of the following line of Balmer series has longest wavelength?
  - $H_\alpha$
  - $H_\beta$
  - $H_\gamma$
  - All have the same value
- Hydrogen atom can give spectral lines in the series named as Lyman, Pfund, Brackett, Balmer and Paschen. Which of the following is correct?
  - Paschen series is in visible region
  - Pfund series is in ultraviolet region
  - Brackett series is in infrared region
  - Balmer series is in X-ray region
- The shortest wavelength of radiation in Paschen series is:
  - $R_H/9$
  - $R_H$
  - $9/R_H$
  - $9 + R_H$

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Ans:	d	b	c	c	d	d	d	d	c	d	c	a	c	c	c	c

31. In the main postulates of Bohr atomic theory, the angular momentum of electron in hydrogen atom is given by the relationship:

- (a)  $mvr = \frac{h}{2\pi}$  (b)  $mvr = \frac{nh}{2\pi}$  (c)  $mvr = \frac{Ze^2}{4\pi\epsilon_0 mv}$  (d)  $mvr = hve$

32. Which of the following has longest wavelength?

- (a) X-rays (b) Ultraviolet light (c) Visible radiations (d) Infrared radiations

33. The ionization energy of hydrogen atom is 13.6 eV. The energy required to remove an electron from 2<sup>nd</sup> orbit is:

- (a) 13.6 eV (b) 3.4 eV (c) 9.5 eV (d) 1.5 eV

34. The angular momentum of electron in nth orbit is:

- (a)  $nh$  (b)  $\frac{2\pi}{nh}$  (c)  $\frac{nh}{2\pi}$  (d)  $\frac{n^3h}{2\pi}$

35. Which of the following transition in the hydrogen atom gives an emission of highest frequency?

- (a)  $n = 2$  to  $n = 1$  (b)  $n = 3$  to  $n = 2$  (c)  $n = 4$  to  $n = 3$  (d)  $n = 5$  to  $n = 2$

36. Number of spectral lines in hydrogen atom is:

- (a) 3 (b) 6 (c) 15 (d) Infinite

37. The concept of stationary orbits was proposed by:

- (a) Neil Boher (b) Rutherford (c) J.J. Thomson (d) Newton

38. The energy of electron in first excited state of H-atom is -3.4 eV its kinetic energy is:

- (a) -3.4 eV (b) -6.8 eV (c) 3.4 eV (d) 6.8 eV

39. The radius of hydrogen atom in its ground state is  $5.3 \times 10^{-11}$  m. After collision with an electron it is found to have a radius of  $21.2 \times 10^{-11}$  m. What is the principal quantum number n of the final state of atom:

- (a)  $n=4$  (b)  $n=2$  (c)  $n=3$  (d)  $n=16$

40. The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between the 2<sup>nd</sup> and infinite orbit:

- (a) 3.40 eV (b) 0.85 eV (c) 1.51 eV (d) 0.66 eV

41. In the lowest energy level of hydrogen atom, the electron has the angular momentum:

- (a)  $\frac{\pi}{h}$  (b)  $\frac{h}{\pi}$  (c)  $\frac{h}{2\pi}$  (d)  $\frac{2h}{\pi}$

42. Which of the following transitions in a hydrogen atom emits photon of the lowest frequency:

- (a)  $n=1$  to  $n=2$  (b)  $n=2$  to  $n=6$  (c)  $n=2$  to  $n=1$  (d)  $n=6$  to  $n=2$

43. An electron in the  $n=1$  orbit of hydrogen atom is bound by 13.6 eV. If a hydrogen atom is in the  $n=3$  state, how much energy is required to ionize it:

- (a) 13.6 eV (b) 4.53 eV (c) 3.4 eV (d) 1.51 eV

44. In Bohr model of the hydrogen atom, the lowest orbit corresponds to:

- (a) Infinite energy (b) Maximum energy (c) Minimum energy (d) zero

45. A hydrogen atom makes a transition from third excited state to first excited state. The energy of the photon emitted is:

- (a) 1.89 eV (b) 12.09 eV (c) 2.55 eV (d) 12.75 eV

46. The radius of electron's second stationary orbit in Bohr's atom is R. the radius of the third orbit will be:

- (a) 3R (b)  $\frac{9R}{4}$  (c)  $\frac{4R}{R}$  (d)  $\frac{R}{3}$

Sr.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.
Ans:	b	d	b	c	a	d	a	c	b	a	c	d	d	c	b	b

47. Hydrogen atom in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. The spectral lines emitted by hydrogen atom according to Bohr's theory will be:

- (a) 1 (b) 2 (c) 3 (d) 4

48. The energy required to knock out the electron in the third orbit of a hydrogen atom is equal to:

- (a) 13.6 eV (b)  $\frac{13.6}{9}$  eV (c)  $\frac{13.6}{3}$  eV (d)  $\frac{3}{16.6}$  eV

49. The size of an atom is:

- (a)  $10^{-8}$  m (b)  $10^{-12}$  m (c)  $10^{-10}$  m (d)  $10^{-14}$  m

50. In the n orbit, the energy of an electron  $E_n = -\frac{13.6}{n^2}$  eV for hydrogen atom. The energy required to take the electron from the first orbit to second orbit will be:

- (a) 10.2 eV (b) 12.1 eV (c) 3.4 eV (d) 13.6 eV

Sr.	47.	48.	49.	50.
Ans:	c	b	c	a

## PRACTICE TEST NO. 2

1. In the Bohr's hydrogen atomic model, the radius of the stationary orbit is directly proportional to:

- (a)  $n^{-1}$  (b)  $n^{-2}$  (c)  $n$  (d)  $n^2$

2. The Lyman series of hydrogen spectrum lies in the region of:

- (a) Infrared (b) Visible (c) Ultraviolet (d) Of X-rays

3. Which one of the series of hydrogen spectrum is in the visible region:

- (a) Lyman series (b) Balmer series (c) Bracket series (d) Paschen series

4. The energy required to remove an electron in a hydrogen atom from  $n=10$  state is:

- (a) 13.6 eV (b) 0.136 eV (c) 1.36 eV (d) 0.0136 eV

5. The ratio of the energies of the hydrogen atom in its first to second orbit of hydrogen atom is:

- (a) 4 (b)  $\frac{1}{4}$  (c)  $\frac{9}{4}$  (d)  $\frac{4}{9}$

6. In any Bohr Orbit of the hydrogen atom, the ratio of Kinetic energy to potential energy of the electron is:

- (a) 2 (b)  $\frac{1}{2}$  (c)  $-\frac{1}{2}$  (d) -2

7. When a hydrogen atom is raised from the ground state to excited state:

- (a) P.E increase and K.E decrease (b) P.E decrease and K.E increase  
(c) P.E increase and K.E increase (d) P.E decrease and K.E decrease

8. The ratio of kinetic energy to the total energy of electron in Bohr orbit is:

- (a) -1 : 1 (b) 1 : 2 (c) -2 : 1 (d) None of these

9. The ratio of the long wavelength limits of Lyman and Balmer series of hydrogen spectrum is:

- (a) 27:5 (b) 5:27 (c) 4:1 (d) 1:4

10. Which of the transitions in hydrogen atom emits a photon of lowest frequency?

- (a)  $n=2$  to  $n=1$  (b)  $n=4$  to  $n=3$  (c)  $n=3$  to  $n=1$  (d)  $n=4$  to  $n=2$

11. According to Bohr's theory the moment of momentum of an electron revolving in 3<sup>rd</sup> orbit of hydrogen atom will be:

- (a)  $2\pi h$  (b)  $\frac{3h}{2\pi}$  (c)  $\frac{\pi}{h}$  (d)  $\frac{2h}{\pi}$

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Ans:	d	c	b	b	a	c	a	a	b	b	b

12. Hydrogen atoms are excited from ground state to the principal quantum number 4. Then the number of spectral lines observed will be:  
 (a) 3 (b) 5 (c) 2 (d) 6
13. When hydrogen atom is in its first excited level, its radius is ..... its ground state radius:  
 (a) Half (b) Twice (c) Same (d) 4 times
14. Energy of electron in a orbit of H-atom is always:  
 (a) Positive (b) Negative (c) Zero (d) Nothing can be said
15. The extreme wavelength of paschen series are:  
 (a)  $0.365 \mu\text{m}$  and  $0.565 \mu\text{m}$  (b)  $0.818 \mu\text{m}$  and  $1.87 \mu\text{m}$   
 (c)  $1.45 \mu\text{m}$  and  $4.04 \mu\text{m}$  (d)  $2.27 \mu\text{m}$  and  $7.43 \mu\text{m}$
16. In a hydrogen atom, which of the following electronic transitions would involve the maximum energy change?  
 (a) From  $n = 2$  to  $n = 1$  (b) From  $n = 3$  to  $n = 2$   
 (c) From  $n = 4$  to  $n = 2$  (d) From  $n = 3$  to  $n = 2$
17. When the electron in the hydrogen atom jumps from 2<sup>nd</sup> orbit to 1<sup>st</sup> orbit, the wavelength of emitted radiation is  $\lambda$ . When an electron jumps from 3<sup>rd</sup> orbit to 1<sup>st</sup> orbit the wavelength of emitted radiation is:  
 (a)  $\frac{27}{32}\lambda$  (b)  $\frac{32}{27}\lambda$  (c)  $\frac{25}{13}\lambda$  (d)  $\frac{13}{25}\lambda$
18. The ratio of the energies of the hydrogen atom in first to second excited state is:  
 (a)  $\frac{4}{9}$  (b)  $\frac{9}{4}$  (c)  $\frac{1}{4}$  (d)  $\frac{4}{1}$
19. According to Bohr's atomic model:  
 (a) An atom has heavy, negatively charged nucleus  
 (b) The electron radiate energy only when it jumps to inner orbit  
 (c) The electron can move only in particular orbit  
 (d) Both B and C
20. When an electron drop from any higher orbit i.e.  $n \geq 3$  to the second orbit  $n = 2$ , the spectral lines produced fall in the region:  
 (a) Visible (b) Infrared (c) Ultraviolet (d) X-rays
21. A hydrogen atom in ground state absorbs  $10.2\text{eV}$  of energy. The orbital angular momentum of the electron is increased by:  
 (a)  $1.05 \times 10^{-34} \text{ Js}$  (b)  $3.16 \times 10^{-34} \text{ Js}$  (c)  $2.11 \times 10^{-34} \text{ Js}$  (d)  $4.22 \times 10^{-34} \text{ Js}$
22. Which of the following correctly represents the lowest state and all the possible excited state of Bracket series of the hydrogen atom?  
 (a)  $n = 1, n = 2$  to  $\infty$  (b)  $n = 2, n = 3$  to  $\infty$   
 (c)  $n = 3, n = 4$  to  $\infty$  (d)  $n = 4, n = 5$  to  $\infty$
23. The Lyman transition involve:  
 (a) smallest change of kinetic energy (b) Smallest change of potential energy  
 (c) Smallest change of total energy (d) Largest change of total energy
24. Which of the following is true for number of spectral lines in going from Lyman series to Pfund series?  
 (a) Increase (b) Decreases (c) Unchanged (d) May decreases or increases

Sr.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Ans:	d	d	b	b	a	a	b	d	a	a	d	d	b

25. The de-Broglie wavelength of an electron in the first Bohr orbit is:  
 (a) Equal to one fourth the circumference of the first orbit  
 (b) Equal to half the circumference of the first orbit  
 (c) Equal to twice the circumference of the first orbit  
 (d) Equal to the circumference of the first orbit
26. Molybdenum is used as target element for production of x-rays because it is:  
 (a) A heavy element and can easily absorb high velocity electrons  
 (b) A heavy element with a high melting point  
 (c) An element having high thermal conductivity  
 (d) Heavy and can easily deflect electrons
27. The electron is in 2<sup>nd</sup> excited state in hydrogen atom. Number of spectral lines emitted will be:  
 (a) 2 (b) 4 (c) 3 (d) 1
28. The total energy of electron in the first excited state of hydrogen atom is  $-3.4 \text{ eV}$ . The potential energy of electron in this state is:  
 (a)  $-3.4 \text{ eV}$  (b)  $3.4 \text{ eV}$  (c)  $-6.8 \text{ eV}$  (d)  $6.8 \text{ eV}$
29. Lyman series of hydrogen atom lies in:  
 (a) Visible region (b) Infrared (c) U.V region (d) None of these
30. When an electron makes a transition from 4<sup>th</sup> energy level to 2<sup>nd</sup> energy level in hydrogen atom then the wavelength of emitted radiation would be:  
 (a)  $\frac{3}{16}R_H$  (b)  $\frac{16}{3}R_H$  (c)  $\frac{3}{16R_H}$  (d)  $\frac{16}{3R_H}$
31. Helium was first identified in the \_\_\_\_\_ using spectroscopy:  
 (a) Earth (b) Jupiter (c) Sun (d) Stars
32. If  $L$  is angular momentum of electron in the 2<sup>nd</sup> orbit of hydrogen atom then angular momentum in the fourth orbit will be:  
 (a)  $2L$  (b)  $3L$  (c)  $L/2$  (d)  $L/3$
33. Atomic spectrum of hydrogen is:  
 (a) Continuous spectrum (b) Band spectrum  
 (c) Line spectrum (d) None of these
34. Electron revolving around the nucleus behaves as a:  
 (a) Transverse wave (b) -wave  
 (c) Longitudinal wave (d) Stationary wave
35. K.E of electron in the  $n$ th orbit of hydrogen atom is:  
 (a)  $K_e/2r_n$  (b)  $K_e/r_n$  (c)  $K_e^2/r_n$  (d)  $K_e^2/2r_n$
36. The longest wavelength of spectral line for Balmer series is:  
 (a)  $36R_H/5$  (b)  $36R_H$  (c)  $36/5R_H$  (d) None of these
37. The red line of the Balmer series corresponds to transition between energy levels having quantum numbers:  
 (a) 4 and 2 (b) 3 and 2 (c) 5 and 2 (d)  $\infty$  and 2
38. The value of Rydberg's constant " $R_H$ " is:  
 (a)  $1.0974 \times 10^{-7} \text{ m}^{-1}$  (b)  $1.0974 \times 10^7 \text{ m}^{-1}$  (c)  $1.0974 \times 10^{-7} \text{ m}$  (d)  $1.0974 \times 10^7 \text{ m}$
39. The energies required in electron volt to remove an electron from three lowest excited states of hydrogen atom are:  
 (a) 13.6, 3.4, 1.5 (b) 13.6, 10.2, 3.4 (c) 13.6, 6.8, 3.7 (d) 3.4, 1.5, 0.85
40. As the quantum number increases, the energy difference between consecutive energy levels of an atom:  
 (a) Increases (b) Decreases (c) Remains same (d) Becomes infinite

Sr.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	d	b	c	c	c	d	c	a	c	d	d	c	b	b	a	b

## 41. According to Bohr's Model of Hydrogen atom:

- (a) The linear velocity of electrons is quantized  
 (b) The total linear momentum of electrons is quantized  
 (c) The angular momentum of electrons is quantized  
 (d) All of these

## 42. The energy of an electron:

- (a) Is greater in outer orbit than in inner orbits  
 (b) Is always the same whichever the orbit may be  
 (c) Decreases as the quantum number increase  
 (d) Is greater in inner orbits than in outer orbits

## 43. Which of the following is true?

- (a) Lyman series is a continuous spectrum  
 (b) Paschen series is a line spectrum in the infrared  
 (c) Both 'a' and 'b'  
 (d) None of these

## 44. A hydrogen atom (ionization potential 13.6 eV) makes a transition from third excited state to first excited state. The energy of photon emitted in the process is:

- (a) 1.89 eV (b) 2.55 eV (c) 12.09 eV (d) 12.75 eV

## 45. To explain his theory, Bohr used:

- (a) Conservation of linear momentum  
 (b) Conservation of angular momentum  
 (c) Conservation of quantum frequency  
 (d) Conservation of energy

## 46. Hydrogen atoms are excited from ground state to the principal quantum number 5. Then the number of spectral lines observed will be:

- (a) 3 (b) 6 (c) 5 (d) 10

## 47. Minimum excitation potential of Bohr's first orbit in hydrogen atom is:

- (a) 13.6 eV (b) 3.4 V (c) 10.2 V (d) 3.6 v

## 48. The energy required to excite an electron from the ground state of hydrogen atom to the first excited state, is:

- (a)  $1.602 \times 10^{-14}$  J (b)  $1.619 \times 10^{-16}$  J (c)  $1.632 \times 10^{-18}$  J (d)  $1.656 \times 10^{-20}$  J

## 49. The ratio of longest to shortest wavelength in Brackett series of hydrogen spectra is:

- (a)  $\frac{25}{9}$  (b)  $\frac{17}{6}$  (c)  $\frac{9}{5}$  (d)  $\frac{4}{3}$

## 50. The energy of hydrogen atom in its ground state is -13.6 eV. The energy of the level corresponding to the quantum number n is equal 5 is:

- (a) -5.40 eV (b) -2.72 eV (c) -0.85 eV (d) -0.54 eV

## 51. Radius of the first orbit of the electron in a hydrogen atom is 0.53 Å. So, the radius of the third orbit will be:

- (a) 2.12 Å (b) 4.77 Å (c) 1.06 Å (d) 1.59 Å

## 52. Energy of an electron in an excited hydrogen atom is -3.4 eV. Its angular momentum will be:

- (a)  $1.11 \times 10^{-34}$  J sec (b)  $1.51 \times 10^{-31}$  J sec (c)  $2.11 \times 10^{-34}$  J sec (d)  $3.72 \times 10^{-34}$  J sec

## 53. The wavelength of light emitted from second orbit to first orbit in a hydrogen atom is:

- (a)  $1.215 \times 10^{-7}$  m (b)  $1.215 \times 10^{-5}$  m (c)  $1.215 \times 10^{-4}$  m (d)  $1.215 \times 10^{-3}$  m

Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.
Ans:	d	a	b	b	d	b	c	c	a	d	b	c	a

54. Energy of the electron in n orbit of hydrogen atom is given by  $E_n = -\frac{13.6}{n^2}$  eV. The amount of energy added to transfer electrons from first orbit to third orbit is:

- (a) 13.6 eV (b) 3.4 eV (c) 12.09 eV (d) 1.51 eV

## 55. In nth shell of hydrogen atom velocity of electron is

- (a)  $\frac{n^2 h}{2\pi k e^2}$  (b)  $\frac{2\pi k e^2}{n h}$  (c)  $\frac{2\pi k e}{n^2 h}$  (d)  $\frac{2\pi^2 h}{k e^2}$

56. Energy E of a hydrogen atom with principal quantum number n is given by  $E = -\frac{13.6}{n^2}$  eV. The energy of a photon ejected when the electron jumps from n = 3 state to n = 2 state of hydrogen is approximately:

- (a) 1.5 eV (b) 0.85 eV (c) 3.4 eV (d) 1.9 eV

## 57. The Bohr model of atoms:

- (a) Assumes that the angular momentum of electrons is quantized  
 (b) Uses Einstein's photo-electric equation  
 (c) Predicts continuous emission spectra for atoms  
 (d) Predicts the same emission spectra for all types of atoms

## 58. The kinetic energy of an electron revolving around a nucleus will be:

- (a) Four times of P.E (b) Double of P.E  
 (c) Equal to P.E (d) Half of it P.E

## 59. The spectrum of perfect black body is:

- (a) Line (b) Band  
 (c) Continuous (d) All of these

## 60. Which source is associated with a line emission spectra:

- (a) Electric fibre (b) Red traffic light  
 (c) Neon street sign (d) Sun

## 61. Sun spectra also has dark lines in pattern which corresponds to

- (a) Absorption (b) Emission (c) Release (d) Free particle

## 62. Atomic spectra is a ..... spectra:

- (a) Continuous (b) Discrete (c) Both a and b (d) None of these

63. When electron series terminates on 4<sup>th</sup> orbit ..... series is obtained:

- (a) Balmer (b) Pfund (c) Paschen (d) Bracket

64. The atom is excited to an energy level  $E_i$  from its ground state energy level  $E_0$ , the wavelength of the radiations emitted is:

- (a)  $\frac{(E_0 - E_i)}{hc}$  (b)  $\frac{hc}{(E_i - E_0)}$  (c)  $\frac{(E_i - E_0)}{hc}$  (d)  $\frac{E_i - E_0}{hc - hc}$

## 65. If electrons of charge 'e' moving with velocity 'v' are accelerated through a potential difference 'V' and strike a metal target, then velocity of electrons is:

- (a)  $\frac{Ve}{m}$  (b)  $\sqrt{\frac{Ve}{2m}}$  (c)  $\sqrt{\frac{Ve}{m}}$  (d)  $\sqrt{\frac{2Ve}{m}}$

Sr.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.	64.	65.
Ans:	c	b	d	a	d	c	c	a	b	a	b	d

## UNIT 13 &gt;&gt;

## NUCLEAR PHYSICS

## PRACTICE TEST NO. 1

- The particles equal in mass or greater than protons are called:
  - Mesons
  - Baryons
  - Both a and b
  - None of these
- The sum of charge of one top quark and one strange quark will result in the charge of:
  - $\bar{d}$
  - $\bar{u}$
  - $\bar{c}$
  - $\bar{t}$
- Radiations bend in opposite direction in magnetic field are:
  - $\alpha$  and  $\beta$  radiations
  - $\gamma$  and  $\beta$  radiation
  - $\alpha$  and  $\gamma$  radiations
  - All radiations
- The tumors are irradiated by:
  - $\alpha$ -rays
  - $\gamma$ -rays
  - $\beta$ -rays
  - proton
- Which one is used for treatment of liver cancer?
  - Nal
  - Kr
  - Cobalt-60
  - Na-24
- Atomic number of a nucleus is Z and atomic mass is M. The number of neutron is:
  - $M - Z$
  - M
  - Z
  - $M + Z$
- The electron emitted in beta radiation originates from:
  - Inner orbits of atoms
  - Free electrons existing in nuclei
  - Decay of a neutron in a nucleus
  - Photon escaping from the nucleus
- Radioactivity is:
  - Irreversible process
  - Self disintegration process
  - Spontaneous process
  - All of the above
- Ten grams of radioactive material kept in an open container beta-decays with half-life of 270 days. The weight of the material inside the container after 540 days will be very nearly:
  - 10 g
  - 5 g
  - 2.5 g
  - 1.25 g
- Of the following atoms  $^{14}_6\text{C}$ ,  $^{13}_7\text{N}$ ,  $^{222}_{88}\text{Ra}$ ,  $^{14}_7\text{N}$ ,  $^{16}_8\text{O}$  and  $^{222}_{86}\text{Rn}$  a pair of isobars is:
  - $^{13}_7\text{N}$ ,  $^{14}_7\text{N}$
  - $^{14}_6\text{C}$ ,  $^{14}_7\text{N}$
  - $^{14}_6\text{C}$ ,  $^{13}_7\text{N}$
  - $^{14}_6\text{C}$ ,  $^{16}_6\text{O}$
- A radioactive sample with a half life of 1 month has activity  $2 \mu\text{Ci}$ . Which of the following was its activity two months earlier?
  - $4 \mu\text{Ci}$
  - $6 \mu\text{Ci}$
  - $8 \mu\text{Ci}$
  - $10 \mu\text{Ci}$
- During a positive beta decay:
  - A positron already present in nucleus is ejected from nucleus
  - A proton in the nucleus decays emitting a positron
  - Both A and B
  - A part of binding energy of nucleus is converted into an a positron
- The most stable element is:
  - Copper
  - Uranium
  - Iron
  - Cobalt
- No. of  $\alpha$  and  $\beta$  - particle emitted in the reaction  $^{90}_{20}\text{X}^{200} \rightarrow ^{80}_{18}\text{Y}^{168}$ :
  - 6,6
  - 6,8
  - 8,6
  - 8,8

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ans:	b	a	a	b	c	a	c	c	c	b	c	b	c	c

- In majority of a radioactive elements the ratio of number of neutrons to that of protons:
  - Decrease
  - Increases
  - Remain constant
  - Sometimes decreases and sometimes increases
- Among the radioactivity radiations, which one has greater speed?
  - $\alpha$ -particle
  - $\beta$ -particle
  - $\gamma$ -ray
  - All have same speed
- The half life of uranium-238 is \_\_\_\_\_ while the half life of radium-226 is \_\_\_\_\_.
  - 3.8 days, 23.5 minutes
  - 23.5 minutes, 3.8 days
  - 1620 years,  $4.5 \times 10^9$  years
  - $4.5 \times 10^9$  years, 1620 years
- The time interval in which the mass of a radioactive substance is reduced to half of its initial value is called:
  - Mean life
  - Half life
  - Complete life
  - Decay life
- Different biological effects of radiation can be classified into:
  - Somatic effect
  - Genetic effect
  - Curie effect
  - Both a and b
- For same absorbed dose,  $\alpha$ -particles are:
  - 10 times more damaging than X-rays
  - 20 times less damaging than X-rays
  - 10 times less damaging than X-rays
  - 20 times more damaging than X-rays
- The background radiation to which we are exposed, an average, is:
  - 2 Sv per year
  - 2 Sv per month
  - 2 mSv per month
  - 2 mSv per year
- To measure pesticide levels, a pesticide can be identified with a radioisotope, such as (in tracer technique):
  - Chlorine-36
  - Sodium-24
  - Cobalt-60
  - Iodine-131
- After six half lives, the number of atoms decayed of a radioactive sample will be \_\_\_\_\_ times initial number of atoms:
  - $\frac{1}{64}$
  - $\frac{1}{32}$
  - $\frac{63}{64}$
  - $\frac{31}{32}$
- A radioactive element X with a half-life of 2 hours decay giving a stable element Y. After a time of t hours the ratio of X to Y atoms is 1:7. Then t is equal to:
  - 4
  - Between 4 and 6
  - 6
  - 14
- The radioactivity of an element becomes  $\frac{1}{4}$  th of its original value in 60 seconds. Then the half value period is:
  - 5 sec
  - 10 sec
  - 20 sec
  - 30 sec
- For the total number N of a radioactive element, the number of elements  $\Delta N$  decayed in a time  $\Delta t$  are given by  $\Delta N = -\lambda N \Delta t$ . Where  $\lambda$  represents:
  - Wavelength of the emitted radiations
  - Half-life period of the element
  - Disintegration constant
  - None of these
- Which one of the following combination of radioactive decay results in the formation of an isotope of the original nucleus?
  - One alpha and four beta
  - One alpha and one beta
  - One alpha and two beta
  - Four alpha and one beta
- For the radiotherapy of a patient, it is required to double the absorbed dose in gray. What step must be taken:
  - Energy must be quartered
  - Energy must be halved
  - Energy must be raised four times
  - Energy must be doubled
- Carbon-14 releases:
  - $\alpha$ -radiations
  - $\beta$ -radiations
  - Neutrons
  - $\gamma$ -rays

Sr.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
Ans:	b	c	d	b	d	d	d	a	c	c	d	c	c	d	b

30. 100 rad is equal to  
(a) 1 Gy (b) 0.01 Gy (c) 10 Gy (d) 0.001 Gy
31. In the effects of exposure to high levels of ionizing radiation, radiation sickness is caused when equivalent dose in milli sievert is:  
(a) 1000 (b) 2500 (c) 1500 (d) 2000
32. Equal doses of difference radiations:  
(a) Produce same biological effect (b) Do not produce same biological effect  
(c) Produce same damage to body (d) Produce same damage to eyes
33. Average radiation dose for having a chest X-ray is:  
(a) 30 mSv (b) 750 mSv (c) 200 mSv (d) 1000 mSv
34.  $C^{14}$  has half-life 5700 years. At the end of 11400 years, the actual amount left is  
(a) 0.0625 of original amount (b) 0.5 of original amount  
(c) 0.25 of original amount (d) 0.125 of original amount
35. The number of protons in the nucleus is called \_\_\_\_\_ number.  
(a) Atomic (b) Charge (c) Atomic or charge (d) Neither atomic nor charge
36. A radioactive source has a half-life of 80 s. How long will it take for 7/8 of the source to decay?  
(a) 10s (b) 70s (c) 240s (d) 640s
37. Wave nature of He atom is similar to  
(a) Alpha rays (b) Beta rays (c) Gamma rays (d) X-rays
38. The artifacts and fossils are used to estimate ages by measured \_\_\_\_\_ content.  
(a) Mineral (b) Chemical (c) Radioactive (d) All of these
39. Nuclear force is  
(a) Spin independent (b) Both charge and spin independent  
(c) Spin dependent but charge independent (d) Charge dependent
40. One isotope of Uranium is U-238. Any other isotope of Uranium must have:  
(a) 146 protons (b) 92 protons (c) 92 neutrons (d) 146 neutrons
41. How many milligrams of tritium will remain after 49.2 years if the starting amount is 32 mg? the half-life of tritium is 12.3 years.  
(a) 8mg (b) 2mg (c) 1mg (d) 4mg
42. Total charge on any nucleus is:  
(a) Ne (b) Wq (c) Ze (d) Ne
43. Mean life of a radioactive element is 1 year. Then its half life (in years) is....  
(a) 1.4 (b) 1 (c) 0.693 (d) 0.5
44. If the binding energy of the deuterium is 2.23 MeV. The mass defect given in a.m.u is:  
(a) -0.0024 (b) -0.0012 (c) 0.0012 (d) 0.0024
45. Which ray shows comparable penetrating power to x rays:  
(a) Alpha (b) Beta (c) Gamma (d) Radio waves
46. The H atom has \_\_\_\_\_ quarks.  
(a) 1 (b) 2 (c) 3 (d) 4
47. What will be the product after alpha decay of U-238?  
(a) Th-234 (b) Po-234 (c) Rn-234 (d) None of these
48. What is the fraction of atom left after 10 half life of a substance?  
(a) 1/512 (b) 1/1024 (c) 1/256 (d) 1/2048
49. Radioactive wastes are of:  
(a) Two types (b) Five types (c) Three types (d) Four types
50. SI unit of equivalent dose is:  
(a) Gray (b) Rad (c) Sievert (d) Rem

Sr.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	a	a	b	c	c	c	c	a	c	c	b	b	c	c	d	c	c	a	b	b	c

## PRACTICE TEST NO. 2

1. When gamma photon is entered in nucleus it \_\_\_\_\_  
(a) De-excite the Nucleus (b) Excite the Nucleus  
(c) Scatter by atom (d) None of these
2. A radioactive decay rate of  $3.7 \times 10^{10}$  disintegrations per second defines the unit of measurement known as the:  
(a) Curie (b) Rutherford (c) Rontgen (d) Rad
3.  $\beta$  decay means emission of electron from  
(a) Radioactivity nucleus (b) Innermost electron orbit  
(c) A stable nucleus (d) Outer most electron orbit
4. Tracers are widely used in:  
(a) Medicine to detect malignant tumors  
(b) Agriculture to study up take of fertilizer  
(c) Agriculture to understand photosynthesis (d) All of these
5. A radioactive element emits 200 particles per second. After three hours 25 particles per second are emitted. The half life period of element will be:  
(a) 80 minutes (b) 70 minutes (c) 60 minutes (d) 50 minutes
6. LED TV produces \_\_\_\_\_ radiation.  
(a) Alpha (b) Beta (c) Gamma (d) None of these
7. Which isotope has highest momentum when moving with same velocity?  
(a) Protium (b) Deuterium (c) Tritium (d) All of these have same momentum
8. \_\_\_\_\_ are used to monitor radiation received by workers in nuclear facilities:  
(a) Wilson cloud chamber (b) Radiotracers  
(c) Film badge dosimeter (d) Scalar
9. Which of the following particle(s) can cause redness and sores on the skin:  
(a)  $\alpha$ -particles (b)  $\beta$ -particles (c)  $\gamma$ -particles (d) Both A and B
10. A radioactive nuclide decays by emitting an alpha particle, a beta particle and a gamma ray photon, the change in the nucleon number will be:  
(a) -4 (b) -1 (c) -2 (d) -3
11. Examples of somatic effect are:  
(a) Induction of cancer (b) Loss of hair  
(c) Drop in white blood cells (d) All of these
12. Damage to skin cells is included in \_\_\_\_\_ effect of radiation:  
(a) Somatic (b) Genetic (c) Curie (d) Becquerel
13. Plutonium decays with a half life of 24000 years. If plutonium is stored for 72000 years, the fraction of it that remains is:  
(a) 1/2 (b) 1/4 (c) 7/8 (d) 1/8
14. Radioactivity is the phenomenon associated with:  
(a) Production of radio waves (b) Reception of radio waves  
(c) Transmission of radio waves (d) Decay of atomic nucleus
15. According to laws of radioactive disintegration, the rate of decay is:  
(a) Same for different elements  
(b) Smaller for elements with smaller nuclear mass  
(c) Different for different elements  
(d) Greater for elements with smaller nuclear mass

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Ans:	b	a	a	d	c	d	c	c	d	a	d	a	d	d	c

16. The total number of protons and neutrons in a nucleus is called:  
 (a) Charge number (b) Electron number  
 (c) Mass number (d) Neutron number
17. If half life of a material is 10 days at STP, then an increasing the pressure two times and reducing the temperature to one half, half life would become:  
 (a) 5 days (b) 10 days (c) 20 days (d) 40 days
18. Which are the percentage of original quantity of the radio active material left after five half lives:  
 (a) 3% (b) 6% (c) 12% (d) 75%
19. A radioactive substance has a half-life of four months. Three -fourth of the substance will decay in:  
 (a) Three months (b) Eight months (c) Four months (d) Twelve months
20. Certain radio-active substance reduces to 25 % of its value in 16 days. Its half-life is:  
 (a) 8 days (b) 32 days (c) 28 days (d) 64 days
21.  $\gamma$ -radiation are emitted due to:  
 (a) De-excitation of atom (b) Excitation of atom  
 (c) De-excitation of nucleus (d) Excitation of nucleus
22. The half life of sodium Na-24  
 (a) 15 hours (b) 45 hours (c) 6 hours (d) 60 days
23. The half-life of polonium is 140 days. After how many days, 16 gm polonium will be reduced to 1 gm (or 15 g will decay):  
 (a) 700 days (b) 280 days (c) 560 days (d) 420 days
24. When free protons and neutrons join to form a nucleus, the energy is:  
 (a) Absorb (b) Destroyed (c) Created (d) Released
25. The mass number of nucleus is equal to the number of:  
 (a) Electrons it contains (b) Protons it contains  
 (c) Neutrons it contains (d) Nucleons it contains
26. The difference between  $^{235}_{92}\text{U}$  and  $^{238}_{92}\text{U}$  atoms is that:  
 (a)  $^{238}_{92}\text{U}$  contains 3 more neutrons  
 (b)  $^{238}_{92}\text{U}$  contains 3 more protons  
 (c)  $^{238}_{92}\text{U}$  contains 3 more protons and 3 more electrons  
 (d)  $^{238}_{92}\text{U}$  contains 3 more neutrons and 3 more electrons
27. Neutrons are particularly more damaging to:  
 (a) Eyes (b) Nose (c) Legs (d) Brain
28. A 40 kg person receives a whole body radiation dose of 20 mrad delivered by  $\alpha$ -particles for which RBE factor is 12. The absorbed energy in joules would be:  
 (a) 1 mJ (b) 10 mJ (c) 0.1 mJ (d) 8 mJ
29. After  $1\alpha$  and  $2\beta$  emissions:  
 (a) Mass number reduces by 3 (b) Mass number reduces by 4  
 (c) Mass number reduces by 6 (d) Atomic number remains unchanged
30. Which of the following statement is not TRUE about  $\alpha$ -radiation?  
 (a) It is produced by unstable nuclei  
 (b) It can penetrate a piece of paper  
 (c) It is a short wavelength electromagnetic photon  
 (d) It can be deflected by a magnetic field

Sr.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Ans:	c	b	a	b	a	c	a	c	d	d	a	a	d	b	c

31. A radioactive material has an initial amount 32 g. After 60 days it reduces to 2g, then the half life of radioactive material is:  
 (a) 8 days (b) 60 days (c) 30 days (d) 15 days
32. A source initially contains  $N_0$  nuclei of a radioactive nuclide. How many of these nuclei have decayed after a time interval of three half lives?  
 (a)  $\frac{N_0}{16}$  (b)  $\frac{15N_0}{16}$  (c)  $\frac{7N_0}{8}$  (d)  $\frac{N_0}{8}$
33. The half-life of a radioactive element is such that  $\frac{7}{8}$  of a quantity of it decays in 12 days. What fraction of it remain undecayed after 24 days?  
 (a) 0 (b)  $\frac{1}{64}$  (c)  $\frac{1}{128}$  (d)  $\frac{1}{32}$
34. Size of nucleus is of the order of:  
 (a)  $10^{-10}$  m (b)  $10^{-15}$  m (c)  $10^{-12}$  m (d)  $10^{-19}$  m
35. When a radioactive nucleus undergoes " $\beta$ " emission then its atomic charge number?  
 (a) May increase by 1 (b) May decrease by 1  
 (c) Remain same (d) Both a and b
36. Which of the following is the correct product of the  $\alpha$ -decay:  $^{226}_{88}\text{Ra} \rightarrow ? + ^4_2\text{He}$ :  
 (a)  $^{230}_{90}\text{Th}$  (b)  $^{231}_{91}\text{Pa}$  (c)  $^{222}_{86}\text{Rn}$  (d)  $^{223}_{87}\text{Fr}$
37. The mass and energy equivalent to a a.m.u respectively:  
 (a)  $1.67 \times 10^{-27}$  kg, 9.30 MeV (b)  $1.67 \times 10^{-27}$  kg, 1 MeV  
 (c)  $1.67 \times 10^{-27}$  kg, 930 MeV (d)  $1.67 \times 10^{-34}$  kg, 1 MeV
38. A radioactive nucleus emits a beta particle. The parent and daughter nuclei are:  
 (a) Isotopes (b) Isotones (c) Isotomers (d) Isobars
39. Atomic mass number of an element thorium is 232 and its atomic number is 90. The end product of this radioactive element is an isotope of lead (atomic mass 208 and atomic number 82). The number of alpha and beta particles emitted is:  
 (a)  $\alpha = 3, \beta = 3$  (b)  $\alpha = 6, \beta = 4$  (c)  $\alpha = 6, \beta = 0$  (d)  $\alpha = 4, \beta = 6$
40. In alpha decay, the ratio of decrease in proton number to the decrease in neutron number is:  
 (a) 2 : 1 (b) 1 : 1 (c) 1 : 2 (d) 4 : 1
41. In the uranium radioactive series the initial nucleus is  $^{238}_{92}\text{U}$  and the final nucleus is  $^{206}_{82}\text{Pb}$ . When the uranium nucleus decays to lead, the number of  $\alpha$ -particle and  $\beta$ -particle are:  
 (a)  $8\alpha, 6\beta$  (b)  $8\alpha, 8\beta$  (c)  $10\beta, 6\alpha$  (d)  $12\alpha, 6\beta$
42. Curie is a unit of:  
 (a) Disintegration constant (b) Radioactive mass (c) Activity (d) Atomic number
43. Which of the following is/are hadrons?  
 (a) Electrons (b) Neutrons (c) Quarks (d) Leptons
44. A radioactive substance has a half life of four months. Three -fourth of the substance will decay in:  
 (a) 3 months (b) 8 months (c) 4 months (d) 12 months
45. Radiation which strongly interacts with matter due to its charge and has a short range as compared to gamma radiations is:  
 (a) Alpha radiation (b) X-rays (c) Beta radiation (d) None of these
46. Antiparticle of electron is:  
 (a)  $^0_1\text{n}$  (b)  $^1_1\text{H}$  (c) Positron (d) Neutrino
47. A radioactive substance has a half-life of 1 year. The fraction of this material, that would remain after 5 years will be:  
 (a) 1/32 (b) 1/16 (c) 15/16 (d) 31/32

Sr.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.
Ans:	d	c	b	b	d	c	c	d	b	b	a	c	b	b	a	c	a

48. A radioactive nucleus undergoes a series of decay according to the scheme  $A(\alpha), A_1(\beta), A_2(\alpha), A_3(\gamma), A_4$ . If the mass number and atomic number of  $A$  are 180 and 72 respectively, then what are these number for  $A_4$ ?
- (a) 192 and 69 (b) 174 and 70  
(c) 172 and 69 (d) 176 and 70
49. The half-life of radium is 1600 years. What fraction of a sample of radium will be disintegrated after 6400 years?
- (a)  $7/8$  (b)  $1/6$  (c)  $15/16$  (d)  $1/8$
50. The SI unit of decay constant is:
- (a) M (b)  $m^{-1}$  (c)  $s^{-1}$  (d)  $ms^{-1}$

Sr.	48.	49.	50.
Ans:	c	c	c

## PRACTICE TEST NO. 3

1. Which is the bigger unit of radioactivity?
- (a) Curie (b) Rutherford (c) Becquerel (d) None of these
2.  $1\text{ u}$  (unified mass scale) is equal to:
- (a) 785 MeV (b) 880 MeV (c) 900 MeV (d) 931 MeV
3. The presence of neutron in atomic nucleus was firstly discovered by:
- (a) Rutherford (b) Bohr (c) Chadwick (d) Michelson
4. The end product of the decay of  ${}^{90}\text{Th}^{232}$  is  ${}^{82}\text{Pb}^{208}$ . Which of the following are the number of alpha and beta particles emitted respectively?
- (a) 3, 3 (b) 6, 4 (c) 4, 6 (d) 6, 0
5. In radioactivity the daughter nucleus is:
- (a) Always stable (b) Always unstable  
(c) May be unstable (d) Converted to photons
6. In gamma ray emission from a nucleus:
- (a) Only the proton number changes  
(b) Only the neutron number changes  
(c) There is no change in the proton number and the neutron number  
(d) Both the neutron number and the proton number change
7.  ${}^{238}_{92}\text{U}$  decays through a series of transformations to final stable nuclide. The particles emitted in the successive are:  $\alpha\beta\beta\alpha$ . Which nuclide is not produced during the series of transformation?
- (a)  ${}^{226}_{88}\text{Ra}$  (b)  ${}^{230}_{90}\text{Th}$  (c)  ${}^{234}_{91}\text{Pa}$  (d)  ${}^{234}_{92}\text{U}$
8. Which of the following is true about  $\alpha$ -particle?
- (a) Can cause extensive damage due to ionization in body  
(b) Have relatively small penetration power in body  
(c) Have relatively large penetration power in body  
(d) Both a and b
9. One curie is equal to:
- (a)  $3.7 \times 10^7$  disintegration per second (b)  $3.7 \times 10^8$  disintegration per second  
(c)  $3.7 \times 10^9$  disintegration per second (d)  $3.7 \times 10^{10}$  disintegration per second
10.  $10\text{ J kg}^{-1} =$  \_\_\_\_\_:
- (a) 10 Gy (b) 1000 rad (c) 0.1 rad (d) Both a and b

Sr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Ans:	a	d	c	b	c	c	a	b	d	d

11. The half-value period and the mean value period of a radioactive element are denoted by  $T_h$  and  $T_m$  respectively. Then:
- (a)  $T_h = T_m$  (b)  $T_h > T_m$  (c)  $T_h = 0.693T_m$  (d)  $T_h \geq T_m$
12. Half-life of two radioactive substance A and B are respectively 20 minutes and 40 minutes. Initially the sample of A and B have equal number of nuclei. After 80 minutes, the ratio of remaining number of A and B nuclei is:
- (a) 1:16 (b) 1:1 (c) 1:4 (d) 4:1
13. Cobalt-57 is radioactive, emitting  $\beta$  particles. The half-life for this is 270 days. If 100 mg of this is kept in an open container, the mass of Cobalt-57 after 540 days will be:
- (a) 50 mg (b)  $\frac{50}{\sqrt{2}}$  mg (c) 25 mg (d) Zero
14. Which of the following particle has the greatest mass?
- (a) Electron (b) Proton (c) Positron (d) Photon
15. The decay constant of a radioactive element with half-life of 9.75 hours is:
- (a)  $9.70 \times 10^{-1} s^{-1}$  (b)  $1.97 \times 10^5 s^{-1}$   
(c)  $1.97 \times 10^{-5} s^{-1}$  (d)  $1.97 \times 10^{10} s^{-1}$
16. The mass ratio of two radio-isotopes is 3:1. Their half-lives are 12 and 16 hrs respectively. The ratio of their mass after two days will be:
- (a) 2:1 (b) 3:2 (c) 4:3 (d) 5:4
17. In the effects of exposure to high levels of ionizing radiation, death of 60 percent of people exposed is caused when equivalent dose in milli sievert is
- (a) 2500 (b) 4000 (c) 1500 (d) 2000
18. Relative biological effectiveness (RBE) of X-rays,  $\gamma$ -rays and  $\alpha$ -particles of 30 keV or more is
- (a) 1 (b) 30 (c) 10 (d) 1.7
19. The effect of radiation on body absorbing it relates to a quantity called:
- (a) RBE (b) Radiation strength  
(c) Extra dose (d) Absorbed dose
20. Gray in terms of SI base units can be expressed as:
- (a)  $\text{kgms}^{-2}$  (b)  $\text{Kgm}^2\text{s}^{-2}$  (c)  $\text{m}^2\text{s}^{-2}$  (d)  $\text{m}^{-2}\text{s}^2$
21. How much dose is absorbed by a person who watches T.V. per year?
- (a) 10 mSv (b) 30 mSv (c) 200 mSv (d) 1000 mSv
22. Chromosome abnormalities due to radiation exposure can cause:
- (a) Cancer (b) Abnormalities in future generations  
(c) Eye cataracts (d) All of these
23. The nuclear forces are considered as
- (a) Strong force (b) Weak force (c) Electromagnetic Force (d) All of these
24. The source of gamma radiation is
- (a) Outside nucleus (b) Inside nucleus (c) Electron transition (d) None of these
25. Numbers of neutrons present in a nucleus is given by
- (a)  $N = A + Z$  (b)  $N = A - Z$  (c)  $N = AZ$  (d)  $N = Z - A$
26. Radiation can cause
- (a) Burning (b) Cancer (c) Flu (d) All of these
27. Beta particle is actually a
- (a) Fast moving electrons (b) Slow moving electron  
(c) Electron at rest (d) None of these

Sr.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Ans:	c	c	c	b	c	b	b	a	a	c	a	d	a	b	b	d	a

28. The charge on gamma rays is:  
(a)  $1+$  (b)  $1-$  (c) 0 (d) None of these
29. Ozone reflects \_\_\_\_\_ radiation from sun back into space:  
(a) IR (b) UV (c) Alpha (d) All of these
30. Radon-222 has 136 neutrons, how many neutrons are there in Radon-220:  
(a) 131 (b) 134 (c) 136 (d) None of these
31. If  ${}_{94}\text{Pu}^{238}$  decay an alpha particles the new atomic number and mass number are  
(a) 234, 90 (b) 234, 92 (c) 231, 97 (d) None of these
32. Which of the following has the mass closest in value to that of the positron:  
(a) Proton (b) Electron (c) Photon (d) Neutrino
33. Which of the following is not among elementary particles but are composed of elementary particles?  
(a) Photons (b) Hadrons (c) Quarks (d) Leptons
34. If a C-14 has a half-life of 5730 years, then how long will it take for quantity of C-14 in sample to drop to  $1/8$  of initial quantity?  
(a)  $2.58 \times 10^4$  years (b)  $1.72 \times 10^4$  years  
(c)  $1.44 \times 10^4$  years (d)  $2.58 \times 10^4$  years
35. When  ${}_{90}\text{Th}^{238}$  transforms to  ${}_{83}\text{Bi}^{210}$  then the number of the emitted  $\alpha$  and  $\beta$ -particle is, respectively:  
(a)  $7\alpha, 7\beta$  (b)  $4\alpha, 7\beta$  (c)  $4\alpha, 4\beta$  (d)  $4\alpha, 1\beta$
36. The  $\gamma$ -rays radiographs are used in \_\_\_\_\_ industry:  
(a) Agriculture (b) Medical (c) Sports (d) Entertainment
37. Nucleus of an atom whose atomic mass is 24 consists of:  
(a) 11 electrons, 11 protons and 13 neutrons (b) 11 electrons, 13 protons and 11 neutrons  
(c) 11 protons and 13 neutrons (d) 11 protons and 13 electrons
38. In beta decay:  
(a) The parent and daughter nuclei have same number of protons  
(b) The daughter nucleus has one proton less than the parent nucleus  
(c) The daughter nucleus has one proton more than the parent nucleus  
(d) The daughter nucleus has one neutron more than the parent nucleus
39. Which specie has no net charge?  
(a) An  $\alpha$ -particles (b) A proton (c) An electron (d) A neutrino
40. International system of units (SI) of radioactivity is:  
(a) Becquerel (b) Curie (c) Fermi (d) Moles
41. The half-life period of a radio active nuclide is 3 hours. In 9 hours, its activity will be reduced by a factor of:  
(a)  $1/27$  (b)  $1/6$  (c)  $1/8$  (d)  $1/9$
42. In 1932 James Chadwick discovered:  
(a) Proton (b) Electron (c) Neutron (d) Nucleus
43. Which one of the following is formed during beta emission?  
(a) Isobars (b) Isotones (c) Isodiapheres (d) None of these
44. Half-life of a radioactive substance is how much percent of its mean life?  
(a) 35 % (b) 70 % (c) 50 % (d) 85 %
45. What is the effect of some physical or chemical reaction on radioactivity?  
(a) It slows down (b) It proceeds with a greater speed  
(c) It suddenly stops (d) It is not affected as it is a nuclear phenomenon

Sr.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.
Ans:	c	b	b	b	b	b	b	a	b	c	c	d	a	c	c	a	b	d

46. What is the charge on alpha particle emitted during the phenomenon of radioactivity:  
(a)  $+e$  (b)  $+2e$  (c)  $-e$  (d)  $-2e$
47. Marie Curie and Pierre Curie discovered:  
(a) Uranium and thorium (b) Uranium and cobalt  
(c) Radium and radon (d) Radium and polonium
48. The radioactivity of an element becomes  $\frac{1}{64}$ th of its original value in 60s. Then the half-life period of element is:  
(a) 5 s (b) 10 s (c) 20 s (d) 30 s
49. The initial activity of a sample of a radioactivity isotope containing  $N_0$  nuclei is  $A_0$ . What is the number of unchanged nuclei when the activity has declined to  $\frac{A_0}{2}$ .  
(a)  $0.69 N_0$  (b)  $\frac{N_0}{2}$  (c)  $\frac{0.69 N_0}{2}$  (d)  $\frac{N_0}{1.38}$
50. What will happen in a time of 7 hours, if a radioactive substance has an average life of 7 hours?  
(a) Half of the active nuclei decay  
(b) Less half of the active nuclei decay  
(c) More than half of the active nuclei decay  
(d) All active nuclei decay

Sr.	46.	47.	48.	49.	50.
Ans:	b	d	b	b	c

## PRACTICE TEST NO. 4

1. The degree and type of damage caused by radiation depends on:  
(a) Strength of radiation (b) Property of matter  
(c) Energy of radiation (d) All of these
2. One Becquerel is equal to:  
(a) One disintegration per minute (b) One disintegration per second  
(c) Ten disintegration per minute (d) Ten disintegration per second
3. Radiation absorbed dose (rad) is equal to:  
(a)  $1 \text{ J kg}^{-1}$  (b)  $0.1 \text{ J kg}^{-1}$  (c)  $10 \text{ J kg}^{-1}$  (d)  $0.01 \text{ J kg}^{-1}$
4. What is true about tracer techniques regarding radioactive isotopes?  
(a) Radioactive isotopes help to follow the course of a chemical or biological process  
(b) In this technique, radioactive atoms are substituted for stable atoms of same kind  
(c) Tracers are used in medicine to detect malignant tumors and in agriculture to study uptake of fertilizer by a plant  
(d) All of these
5. The half-life period of a radioactive element is 20 seconds. At any instant the number of radioactive nuclei is one million. Ten seconds later, the number of radioactive nuclei left are:  
(a)  $10^6\sqrt{2}$  (b)  $5 \times 10^5$  (c)  $\frac{10^6}{\sqrt{2}}$  (d)  $2.5 \times 10^5$
6. If an atomic nucleus emits a  $\gamma$ -ray photon:  
(a) Its atomic mass decreases by one but its atomic number remains the same  
(b) Its atomic mass remains the same but its atomic number will decrease by one  
(c) Its atomic mass as well as atomic number remain same but the energy state changes  
(d) Its atomic mass will increase by one unit but its atomic number will remain same

Sr.	1.	2.	3.	4.	5.	6.
Ans:	d	b	d	d	c	c

## UNIT 13

## NUCLEAR PHYSICS

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7. A certain radioactive nuclide of mass number X decays by  $\beta$ -emission and  $\gamma$ -emission to a second nuclide of mass number Y, the correct relation between X and Y is:  
(a)  $Y = X - 4$  (b)  $Y = X + 1$  (c)  $Y = X - 1$  (d)  $Y = X$
8. If  $A_1$  and  $A_3$  represent the decayed atoms of a substance during the first and the third half life periods, then:  
(a)  $A_1 = 3A_3$  (b)  $A_1 = 4A_3$  (c)  $A_1 = A_3/3$  (d)  $A_1 = 2A_3$
9. The time in which about two-third of the atoms of a radioactive sample decay is called:  
(a) Mean life (b) Half life (c) Complete life (d) Decay life
10. Equivalent dose can be written as:  
(a)  $D_e = D \times RBE$  (b)  $\frac{D}{RBE} = D_e$   
(c)  $D = D_e \times RBE$  (d)  $\frac{D}{RBE} = D_e$
11. 1 rad =  
(a) 0.1 gray (b) 0.1 sievert (c) 0.01 gray (d) 0.01 sievert
12. One joule of energy absorbed per kilogram of body is equal to one:  
(a) Rem (b) Gray (c) Roentgen (d) Becquerel
13. The back ground radiation to which we are expose on the average per year is  
(a) 2 rem (b) 5 Sv (c) 2 mSv (d) 3 Sv
14. Absorbed does can be written as:  
(a)  $D = \frac{E}{m}$  (b)  $D = E$  (c)  $D = E \times m$  (d)  $D = \frac{m}{E}$
15. RBE is a quality factor and it is acronym for:  
(a) Reference biological effect (b) Reference body effectiveness  
(c) Relative body effectiveness (d) Relative biological effectiveness
16. In the effects of exposure to high levels of ionizing radiation, temporary low fertility is caused when equivalent dose in sievert is:  
(a) 1.5 (b) 2.5 (c) 1.0 (d) 2.0
17. The nucleus is made up of more neutrons than protons  
(a) H (b) O (c) U (d) None of these
18. What will be the product of beta decay of C-14?  
(a) C-14 (b) N-14 (c) O-14 (d) Be-14
19. How many down quarks in Neutron:  
(a) 1 (b) 2 (c) 3 (d) 4
20. What is the half-time of a radioactive sample (in minutes), if its mean life is 200s?  
(a) 0.69 min (b) 2 min (c) 2.57 min (d) 2.31 min
21. Radiotherapy used in treatment of cancer usually use gamma-rays form:  
(a) Copper-60 (b) Cobalt-60 (c) Gold (d) Silver
22. Half-life of radioactive element means:  
(a) Full life decay (b) Quarter life decay  
(c) Half of decay (d) All of these
23. The half-life of radium is about 1600 years. Of 100 g of radium existing now, 25 g will remain unchanged after:  
(a) 2400 years (b) 3200 years (c) 6400 years (d) 4800 years
24. Which element is used to absorb gamma radiations?  
(a) Co (b) Cl (c) Cl (d) Pb
25. Isotopes of an element have a different number of:  
(a) Photon (b) Neutron (c) Electron (d) Atom
26. The half life of radioactive element is:  
(a) 0.6932 (b) 0.693/2 (c)  $\lambda/0.693$  (d)  $1/\lambda$

Sr.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Ans:	d	b	a	a	c	b	c	a	d	a	c	b	b	d	b	c	b	d	b	b

## UNIT 13

## NUCLEAR PHYSICS

Zayan Publisher

27. The isotope of  $^{235}\text{U}_{92}$  has \_\_\_\_\_ number of neutrons:  
(a) 141 (b) 142 (c) 143 (d) 144
28. An element X with  $A = 14$  and  $Z = 6$  has how many neutrons:  
(a) 6 (b) 8 (c) 14 (d) 20
29. Radioactive material decays by simultaneous emission of two particles with respective half-life 1620 and 810 years. What is the time, in years, after which one-fourth of the material remains of second radioactive material?  
(a) 2430 years (b) 1620 years (c) 3240 years (d) 4260 years
30. Sample of radioactive element with initial mass of 24 gm decayed to 3 gm in 36 minutes. How much of original sample remained after first 12 minutes?  
(a) 12 g (b) 2 g (c) 6 g (d) 8 g
31. \_\_\_\_\_ are such nuclei of an element that have the same atomic number Z, but have different mass number  
(a) Isotopes (b) Isobars (c) Isomers (d) Isotherms
32. Protons and neutrons are composed of smaller particles called  
(a) Quarks (b) Baryons (c) Basons (d) Photons
33. Phosphorus is mostly absorbed by:  
(a) Thyroid gland (b) Bones (c) Lungs (d) Liver
34. How much dose will cause radiation burns to the skin?  
(a) 0.03 rem (b) 3 mSv (c) 300 rem (d) 4 mSv
35. For skin cancer which of following can be used:  
(a) Iodine 131 (b) Carbon 14  
(c) Phosphorous 32 (d) Carbon 12
36. A man of 100 kg absorbs energy 1000 J from radiations. The absorbed dose in Gy is:  
(a) 100 (b) 10 (c) 0.1 (d) 0.01
37. 1 Sv =  
(a) 1 Gy x RBE (b) 2 Gy x RBE (c) 1 Gy/RBE (d) RBE/1 Gy
38. Doses of \_\_\_\_\_ will not cause radiation burns to the skin  
(a) 2 Sv (b) 3 Sv (c) 4 Sv (d) Both "A" & "B"
39. What can be the charge on  $\beta$ -particles emitted during the phenomena of radioactivity?  
(a)  $-e$  (b)  $+e$  (c)  $-2e$  (d)  $\pm e$
40. The half life of uranium-239 is:  
(a) 23.5 min (b) 3.8 days (c) 4500 years (d) 1620 years
41. The masses of two radioactive substances are same and their half-lives are 4 and 8 years respectively. The ratio of their activities after six years will be:  
(a) 1:4 (b) 1:8 (c) 4:1 (d) 8:1
42. When radiations are emitted from a radioactive element, then it will change into new element and this process is known?  
(a) Radioactivity (b) Rate of decay  
(c) Nuclear transmutation (d) Decay law
43. When a radioactive isotope  $^{88}\text{Ra}_{228}$  decays in series by the emission of three  $\alpha$ -particles and a  $\beta$ -particles the isotope finally formed is:  
(a)  $^{84}\text{X}_{220}$  (b)  $^{83}\text{X}_{216}$  (c)  $^{86}\text{X}_{222}$  (d)  $^{83}\text{X}_{215}$
44. Which one of the following emissions takes place in a nuclear reaction?  
 $^{234}_{90}\text{Th} \rightarrow ^{234}_{91}\text{Pa} + \text{_____}$   
(a) Alpha (b) Gamma (c) Beta (d) Photons

Sr.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.
Ans:	c	b	b	a	a	a	b	b	c	b	a	a	d	a	a	c	b	c

45. Which of the following is/are correct?

- (a) Iodine is absorbed by thyroid gland  
(b) Phosphorus and strontium are absorbed by bones  
(c) Cobalt is absorbed by liver  
(d) All of these

46. The SI unit of absorbed dose is:

- (a) Joule (b) Gray (c) Rem (d) Rad

47. The activity or rate of decay of a radioactive source is measured in terms of:

- (a) Becquerel (b) Ohm  
(c) Faraday (d) Coulomb

48. Which of the following is true about radioactive radiations?

- (a) They possess ionization power (b) They can damage cells of living tissues  
(c) They can penetrate in the body (d) All of these

49. Which two nuclei contain the same number of protons?

- (a)  $^{12}_6\text{C}$  and  $^{14}_6\text{C}$  (b)  $^{23}_{11}\text{Na}$  and  $^{24}_{12}\text{Mg}$  (c)  $^{16}_7\text{N}$  and  $^{15}_7\text{N}$  (d)  $^{32}_{14}\text{Si}$  and  $^{32}_{15}\text{P}$

50. The product of half-life and decay constant for any radioactive element is always:

- (a) Constant (b) 1.4 (c) Zero (d) One

Sr.	45.	46.	47.	48.	49.	50.
Ans:	d	b	a	d	a	a

### PRACTICE TEST NO. 5

1. In the heavy elements of periodic table, the number of protons are \_\_\_ than/to the number of neutrons:

- (a) Equal (b) Smaller (c) Greater (d) Almost zero

2. A radioactive nuclide decays by emitting by alpha particle, a beta particle and a gamma ray photon the change in the nucleon number is:

- (a) 4 (b) -2 (c) -4 (d) 2

3.  $\beta$ -particle from various radioactive resources all have \_\_\_\_\_:

- (a) The same mass (b) The same speed (c) The same deflection (d) The same energy

4. In 420 days, the activity of a sample of polonium (Po) fell to  $\frac{1}{8}$ th of its initial value. The half-life of polonium is:

- (a) 140 days (b) 70 days (c) 280 days (d) 210 days

5. A nuclide  $^{208}_{82}\text{X}$  decay to a new nucleus Y by one  $\beta^+$ -emission and three  $\gamma$ -emissions, the nuclide Y is:

- (a)  $^{208}_{82}\text{Y}$  (b)  $^{210}_{81}\text{Y}$  (c)  $^{208}_{81}\text{Y}$  (d)  $^{206}_{82}\text{Y}$

6. Decay of one radioactive nucleus per second is equal to:

- (a) One curie (b) One half life (c) One Becquerel (d) One henry

7. In which radioactive disintegration, neutron dissociates into proton and electron:

- (a)  $\text{He}^{++}$  emission (b)  $\beta$ -emission (c)  $\gamma$ -emission (d) Position emission

8. The half life of radon is 3.8 days. Three fourth of a random sample decay in:

- (a) 5.02 days (b) 15.2 days (c) 7.6 days (d) 11.4 days

Sr.	1.	2.	3.	4.	5.	6.	7.	8.
Ans:	b	c	a	a	b	c	b	c

9. Which of the following statement(s) is /are correct?

- (a) Heavy nuclei have more number of protons than neutrons  
(b) Heavy nuclei have more number of neutrons than protons  
(c) Heavy nuclei are likely to undergo fission than fusion  
(d) Both B and C

10. In  $^{226}_{88}\text{Ra}$  Nucleus, there are:

- (a) 128 protons and 88 neutrons (b) 138 neutrons and 88 protons  
(c) 226 protons and 88 electrons (d) 226 neutrons and 138 electrons

11. 1 rem =

- (a) 1 Sv (b) 0.001 Sv (c) 0.1 Sv (d) 0.01 Sv

12. Most of the cobalt is absorbed by:

- (a) Bones (b) Liver (c) Skin (d) Thyroid gland

13. In the disintegration series  $^{238}_{92}\text{U} \xrightarrow{\alpha} \text{X} \xrightarrow{\beta^-} \text{A} \xrightarrow{\alpha} \text{Z}$  the values of Z and A respectively will be:

- (a) 92, 236 (b) 88, 230 (c) 90, 234 (d) 91, 234

14. The half-life of  $^{234}\text{Th}$  is 24 days. If 8 kilogram of this isotope is present initially, what amount remains after 72 days?

- (a) 2 kg (b) 1 kg (c) 5 kg (d) 4 kg

15. The radioactive nuclide decays by emission of four  $\alpha$ -particle. The nuclide  $^{236}_{92}\text{X}$  finally formed is:

- (a)  $^{220}_{84}\text{X}$  (b)  $^{218}_{82}\text{X}$  (c)  $^{212}_{80}\text{X}$  (d)  $^{208}_{78}\text{X}$

16. How many types of subatomic particles are present in nucleus?

- (a) 3 (b) 2 (c) 4 (d) 5

17. Decay constant  $\lambda$  is given by:

- (a)  $-\frac{\Delta N/N}{\Delta t}$  (b)  $-\frac{\Delta t}{\Delta N/N}$  (c)  $-\Delta N \Delta t$  (d)  $\frac{N}{\Delta N} / \Delta t$

18. The percentage of the original quantity of a radioactive material left after five half lives is approximately:

- (a) 1% (b) 5% (c) 3% (d) 20%

19. If  $\frac{15}{16}$  of radioactive atoms decays in 16 hours, the half-life of element is:

- (a) 16 hours (b) 8 hours (c) 4 hours (d) 2 hours

20. The half life of an element is 160 days. What fraction of it will be left in 80 days?

- (a)  $\frac{1}{8}$  (b)  $\frac{1}{4}$  (c)  $\frac{1}{2}$  (d)  $\frac{1}{\sqrt{2}}$

21. The amount of charge present on strange quark is:

- (a)  $-\frac{1}{3}e$  (b)  $+\frac{1}{3}e$  (c)  $+\frac{2}{3}e$  (d)  $-\frac{2}{3}e$

22. How much of the mass of an atom is concentrated in the nucleus?

- (a) 90% (b) 99% (c) 100% (d) 99.9%

23. What is the respective number of  $\alpha$  and  $\beta$  particles emitted in the following radioactive decay  $^{200}_{90}\text{X} \rightarrow ^{168}_{80}\text{Y}$ :

- (a) 6 and 8 (b) 8 and 8 (c) 6 and 6 (d) 8 and 6

24. A given radioactive sample is reduced from 20 g to 1.25 g in 40 days. Its half life would be:

- (a) 10 days (b) 8 days (c) 5 days (d) None of these

25. Which one has the highest penetrating power?

- (a) Alpha rays (b) Gamma rays (c) Beta Rays (d) Neutron

26. The half-life of an element is 160 days. What amount of it will be left in 80 days?

- (a)  $\frac{1}{8}$  (b)  $\frac{1}{2}$  (c)  $\frac{1}{4}$  (d)  $\frac{1}{\sqrt{2}}$

Sr.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
Ans:	d	b	d	b	d	b	a	b	a	c	c	d	a	d	d	a	d	d

27. The phenomenon of radioactivity is:

- (a) Exothermic change which increases or decreases with temperature
- (b) Nuclear process does not depend on external factor
- (c) Increase on applied pressure
- (d) None of the above

28. Activity is proportional to number of:

- (a) Daughter nuclei
- (b) Un-decayed nuclei
- (c) Decayed nuclei
- (d) Father nuclei

29. Any baryon is a combination of:

- (a) Three quarks
- (b) Two quarks and an anti-quark
- (c) Two quarks
- (d) One quark and one anti-quark

30. A radio-isotope has a half-life of 5 years. The fraction of the atoms of this material that would decay in 15 years will be:

- (a)  $1/8$
- (b)  $2/3$
- (c)  $7/8$
- (d)  $5/8$

31. One eighth of the initial mass of certain radioactive isotope remains un-decayed after one hour. The half-life of the isotope in minutes is:

- (a) 8
- (b) 30
- (c) 20
- (d) 45

32. The same radioactive nucleus may emit:

- (a) All the three  $\alpha$ ,  $\beta$  and  $\gamma$  radiations simultaneously
- (b) All the three  $\alpha$ ,  $\beta$  and  $\gamma$  one after another
- (c) Only  $\alpha$  and  $\beta$  simultaneously
- (d) Only  $\alpha$ ,  $\beta$  or  $\gamma$  at a time

33. The ionizing power when we compare  $\alpha$ ,  $\beta$  and  $\gamma$  rays is:

- (a) Maximum in  $\gamma$ -rays
- (b) Maximum in  $\alpha$ -particles
- (c) Maximum in  $\beta$ -particles
- (d) Same in all the three

34. The activity of the radioactive sample is 1.6 curie and its half life is 5 days. After 10 days its activity will be:

- (a) 0.4 Ci
- (b) 0.5 Ci
- (c) 0.8 Ci
- (d) 0.05 Ci

35. A sample consists of a radioactive nuclide X while another consists of a radioactive nuclide Y. After an interval of time, it is found that  $7/8$  of the atoms of X and  $3/4$  of the atoms of Y have decayed. The ratio (half life of X / half life of Y) is:

- (a)  $2/3$
- (b)  $6/7$
- (c)  $7/6$
- (d)  $3/2$

36. The mass of a neutron is:

- (a)  $1.675 \times 10^{-27}$  kg
- (b)  $1.675 \times 10^{-31}$  kg
- (c)  $9.10 \times 10^{-31}$  kg
- (d)  $1.673 \times 10^{-27}$  kg

37. Among the radioactivity radiations, which one has greater ionization power?

- (a)  $\alpha$ -particle
- (b)  $\beta$ -particle
- (c)  $\gamma$ -ray
- (d) All have same ionization power

38. In radioactivity, the rate of decay:

- (a) Can be increased by the magnetic field
- (b) Can be kept constant by the electric field
- (c) Can be decreased by the magnetic field
- (d) Is not affected by electric and magnetic field

39. According to the equation  ${}^A_ZX \rightarrow {}^AY + 3\alpha$  particles, what are the atomic and mass number of 'Y'?

- (a)  $Z - 6, A - 12$
- (b)  $Z - 2, A - 4$
- (c)  $Z + 1, A$
- (d)  $Z + 3, A$

40. In unified mass scale mass of proton is expressed as:

- (a) 1.007276u
- (b) 0.00055u
- (c) 1.008665u
- (d) 1.00055u

Sr.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans:	b	b	a	c	c	b	b	a	d	a	a	d	a	a

41. The amount of energy absorbed from ionizing radiation per unit mass of absorbing body is called:

- (a) Equivalent dose
- (b) Absorbed dose
- (c) Effective dose
- (d) Ineffective dose

42. The effect(s) of exposure to high levels of ionizing radiation is/are:

- (a) Sterility for about two years on absorbing 2.5 Sv
- (b) Death of 60% of people expose to 4 Sv
- (c) Anemia and Leukaemia
- (d) All of these

43. The rate of decay of a radioactive element, through its life time:

- (a) Remains constant
- (b) Has exponentially decreasing relationship with time
- (c) Has inverse linear relationship with time
- (d) Is directly proportional to time

44. In the nucleus of  ${}^{17}_8\text{O}$ , the number of protons, neutrons and electrons are respectively:

- (a) 8, 9, 0
- (b) 17, 9, 8
- (c) 9, 8, 0
- (d) 8, 9, 8

45. The relation between half-life T and decay constant  $\lambda$ :

- (a)  $\lambda T = 1$
- (b)  $\lambda T = 1/2$
- (c)  $\lambda T = \log_e 2$
- (d)  $\lambda T = \log 2T$

46. How many nucleons are there in an atom of  ${}^{235}_{92}\text{U}$ ?

- (a) 92
- (b) 123
- (c) 235
- (d) 327

47. The circulation of the blood can be studied by using:

- (a) Radioactive sodium-24
- (b) Cobalt-60
- (c) Radioactive Iodine-131
- (d) Phosphorus-32

48. Relative biological effectiveness (RBE) of  $\alpha$ -particles from natural radio activity is:

- (a) 2
- (b) 5
- (c) 10
- (d) 11

49. The maximum safe limit dose for person, working in nuclear power station is:

- (a) 1 mSv per week
- (b) 1 rem per week
- (c) 1 mSv per day
- (d) 1 rem per day

50. In the effects of exposure to high levels of ionizing radiation, sterility for about two years is caused when equivalent dose in sievert is:

- (a) 1.5
- (b) 2.5
- (c) 1.0
- (d) 2.0

Sr.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	b	d	a	d	c	c	a	c	a	b

### PRACTICE TEST NO. 6

1. The effect of radiation on the body absorbing it depends on:

- (a) Nature of radiation
- (b) Energy of radiation
- (c) Part of body absorbing radiation
- (d) All of these

2. Which of the following is/are effects of low level radiation:

- (a) Ulceration
- (b) Stiffening of lungs
- (c) Disruption of blood cells
- (d) Both A and B

3. Technetium is typically used for:

- (a) Plasma volume
- (b) Thyroid uptake scans
- (c) Kidney test
- (d) Plasma volume vein flow

Sr.	1.	2.	3.
Ans:	d	d	

4. Which of the following is the same for isotopes?  
(a) Neutrons (b) Protons (c) Electrons (d) All of them
5. The nucleus shape is considered to be  
(a) Square (b) Rectangle (c) Sphere (d) Circular
6. Which radiation is used in greenhouse effect?  
(a) UV (b) IR (c) X-rays (d) Gamma rays
7. Gamma rays are attracted towards  
(a) Negative plate (b) Positive plate  
(c) No deflection (d) Pass through the medium
8. Number of atoms decaying in a particular period is \_\_\_\_\_ to number of atoms present in the beginning of the period:  
(a) Directly proportional (b) Inversely proportional  
(c) Equal (d) Independent
9. How many curies are there in  $10^{10}$  Bq?  
(a) 0.17 Ci (b) 0.37 Ci (c) 0.27 Ci (d) 0.7 Ci
10. Half-life of radioactive nuclides is 20 hours. What fraction of original activity will remain after 40 hours?  
(a)  $\frac{1}{2}$  (b) 2 (c) 4 (d)  $\frac{1}{4}$
11. If a nucleus release gamma rays its mass become:  
(a) Double (b) Half (c) Unchanged (d) Quarter
12. Sample of radioactive element with initial mass of 24 gm decayed to 3 gm in 36 minutes. How much of original sample remained after the first 12 minutes:  
(a) 12 g (b) 6 g (c) 2 g (d) 8 g
13. Absorbed dose D is defined as energy absorbed from ionization radiation per unit \_\_\_\_\_:  
(a) Mass (b) Charge (c) Time (d) Area
14. 1 rutherford is equal to  
(a)  $10^4$  Bq (b)  $10^6$  Bq (c)  $10^7$  Bq (d)  $10^5$  Bq
15. Radioactive radiations are used to destroy:  
(a) Healthy cells (b) Cancerous cells (c) Bacteria (d) Damaged organs
16. How many quarks in electron:  
(a) 0 (b) 1 (c) 2 (d) 3
17. After certain lapse of time, the fraction of radioactive polonium is found to be 12.5% of initial quantity. If the half life of polonium is 138 days, then duration of time lapse is ..... days.  
(a) 34.5 (b) 414 (c) 276 (d) 125
18. A nucleus emits an  $\alpha$ -particle, followed by two  $\beta$ -particles. The final nucleus will be  
(a) An isotone of the original one (b) An isotope of the original one  
(c) An isobar of the original one (d) None of these
19. As mass number increases, which of the following does not change  
(a) Mass (b) Density (c) Volume (d) Binding energy
20. When the nucleus of an unstable atom emits only gamma radiation, the nucleus must  
(a) Gain energy (b) Loss energy (c) Lose protons (d) Gain protons
21. Curie is a unit of:  
(a) Radioactivity (b) Conductivity (c) Resistivity (d) Isotopes
22. Ten joule of energy absorbed per kg of body is equal to:  
(a) One rem (b) Ten Becquerel (c) One gray (d) Ten gray
23. The strength of radiation source is indicated by its activity measured in:  
(a) Becquerel (b) Gray (c) Curie (d) Sievert

Sr.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
Ans:	b	c	b	c	a	c	d	c	a	a	b	b	a	b	b	b	b	a	d	a

24. Cobalt-60 is a source for:  
(a)  $\alpha$ -rays (b)  $\beta$ -rays (c)  $\gamma$ -rays (d) All of these
25. Which of the following is/are effects of high level radiation:  
(a) Ulceration (b) Stiffening of lungs  
(c) Disruption of blood cells (d) Diarrhea
26. Half life of radium is about 1600 years. In how many years shall the earth loose all its radium due to radioactive decay?  
(a)  $1590 \times 10^6$  years (b)  $1590 \times 10^{12}$  years  
(c)  $1590 \times 10^{24}$  years (d) Never
27. An element is found to be naturally radioactive if it has Z:  
(a) Greater than 82 (b) Less than 82  
(c) Equal to 82 (d) None of these
28. When  ${}^{228}_{90}\text{Th}$  transforms to  ${}^{212}_{83}\text{Bi}$ , then the number of the emitted  $\alpha$  &  $\beta$  particles are respectively:  
(a)  $8\alpha, 7\beta$  (b)  $4\alpha, 7\beta$  (c)  $4\alpha, 1\beta$  (d)  $4\alpha, 4\beta$
29. A radioactive element has half-life of 2 years, its decayed amount after 8 years will be almost:  
(a) 100% (b) 88.25% (c) 93.75% (d) 83.50%
30. The decay constant of a radioactive element is  $1.5 \times 10^{-9}$  per second. Its mean life in seconds will be:  
(a)  $1.5 \times 10^9$  (b)  $6.67 \times 10^8$  (c)  $4.62 \times 10^8$  (d)  $10.35 \times 10^8$
31. Emission of  $\beta$ -rays in a radioactive decay results in a daughter element showing a:  
(a) Change in mass no. but not in charge no. (b) Change in both  
(c) Change in charge no. but not in mass no. (d) Change in either
32. The half life of radio iodine-131 is:  
(a) 8 days (b) 12 days (c) 60 days (d) 45 days
33. Equal doses (absorbed doses) of different radiations:  
(a) Produce same biological effect (b) Do not produce same biological effect  
(c) Always cause cancer (d) Always cause lungs infection
34. The exposure of X-rays and  $\gamma$ -rays are measured in terms of:  
(a) Roentgen (b) Curie (c) Becquerel (d) Ohm
35. Excessive radiation exposure can cause death by variety of mechanism including:  
(a) Alteration of genetic material (b) Destruction of components in bone marrow  
(c) Low grade fever (d) Both a and b
36. The half-life of a radioisotope is 5 years. The fraction of atoms left in this substance after 15 years will be:  
(a) (1) times of original (b) (3/4) times of original  
(c) (1/8) times of original (d) (7/8) times of original
37. Half-life of a radioactive element can be decreased by:  
(a) Increasing temperature (b) Changing volume  
(c) Increasing pressure (d) Can't be decreased
38. Among the radioactivity radiations, which one has greater penetration power?  
(a)  $\alpha$ -particle (b)  $\beta$ -particle  
(c)  $\gamma$ -ray (d) All have same penetration power
39. The nucleus of an atom is always:  
(a) Positively charged (b) Negatively charged  
(c) Neutral (d) May be positively charged or neutral

Sr.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.
Ans:	c	c	d	a	c	c	b	c	a	b	a	d	c	d	c	a

40. When the mass of sample of a radioactive substance decreases, half life of the sample:
- Increases
  - Decreases
  - Stays same
  - May increase or decrease
41. The half life of radioactive element depend upon:
- Temperature
  - Pressure
  - Amount of radioactive substance
  - Nature of element
42. A neutron decays within the nucleus producing:
- One P, one  $\nu$  and one  $\beta^+$
  - One  $\beta^+$ , one  $\beta^-$  and  $\nu$
  - One P, one  $\beta^-$  and one anti neutrino
  - All of the above
43. The energy which binds the nucleons of the nucleus is called:
- Mass defect
  - Fussion energy
  - Binding energy
  - All of these
44. The rate of decay of radioactive element at a given instant of time is  $10^3$  disintegration/second. If the half-life of this element is 1 second, then the rate of decay after 3 second will be:
- 12 per sec
  - 250 per sec
  - 500 per sec
  - 125 per sec
45. Of the following particles, the one which penetrates the atomic nucleus easily is:
- Proton
  - Neutron
  - Deuteron
  - $\alpha$ -particle
46. Radioactive decay is a:
- Random process
  - Regular process
  - Non-spontaneous process
  - Massive process
47. One microgram of matter converted into energy will give:
- $90 \text{ J} \times 10^{10} \text{ J}$
  - $9 \times 10^3 \text{ J}$
  - $9 \times 10^7 \text{ J}$
  - $9 \times 10^5 \text{ J}$
48. Which radioactive element is present in air:
- U
  - Rn
  - Kr
  - Ra
49. After two hours, one sixteen of the starting amount of a certain radioactive isotope remains undecayed. The half-life of the isotope is:
- 15 minutes
  - 45 minutes
  - 30 minutes
  - 1 hour
50. The radioactive decay of uranium into thorium is expressed by the equation  ${}_{92}\text{U}^{238} \rightarrow {}_{90}\text{Th}^{234} + \text{X}$ , where 'x' is:
- An electron
  - A proton
  - A deuteron
  - An alpha particle

Sr.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans:	c	d	c	c	d	b	a	a	b	c	d

## PRACTICE TEST NO. 7

1. The half life of a certain radioactive isotope is 32 hours. What fraction of a sample would remain after 16 hours?
- 0.25
  - 0.71
  - 0.50
  - 0.29
2. In a radioactive decay, neither the atomic number nor the mass number changes. Which of the following would be emitted in the decay process?
- Proton
  - Neutron
  - Electron
  - Gamma ray photon
3. Strontium-90 is used as:
- $\beta$ -source
  - $\gamma$ -source
  - $\alpha$ -source
  - Neutron source
4. Which of the following is the correct product of the  $\alpha$ -decay:  ${}_{88}\text{Ra}^{226} \rightarrow ? + {}_2\text{He}^4$ :
- ${}_{90}\text{Th}^{232}$
  - ${}_{91}\text{Pa}^{231}$
  - ${}_{86}\text{Rn}^{222}$
  - ${}_{87}\text{Fr}^{223}$
5. A radioactive nucleus emits a beta particle. The parent and daughter nuclei are:
- Isotopes
  - Isotones
  - Isotomers
  - Isobars

Sr.	1.	2.	3.	4.	5.
Ans:	b	d	a	c	d

6. When a radioactive nucleus undergoes " $\beta$ " emission then its atomic charge number?
- May increase by 1
  - May decrease by 1
  - Remain same
  - Both a and b
7. Which of the following statements about the mass of separated nucleons and the mass of the nucleus they form is correct?
- The sum of the masses of separated nucleons is greater than the nucleus mass
  - The sum of the masses of separated nucleons is less than the nucleus mass
  - The sum of the masses of separated nucleons is equal to the nucleus mass
  - The sum of the masses of separated nucleons is greater than the nucleus mass only for light.
8. Atomic mass number of an element thorium is 232 and its atomic number is 90. The end product of this radioactive element is an isotope of lead (atomic mass 208 and atomic number 82). The number of alpha and beta particles emitted is:
- $\alpha = 3, \beta = 3$
  - $\alpha = 6, \beta = 4$
  - $\alpha = 6, \beta = 0$
  - $\alpha = 4, \beta = 6$
9. Curie is an unit of:
- Length
  - It is not any unit
  - Activity
  - Atomic number
10. The decay constant  $\lambda$  of a radioactive sample:
- Decrease as the age of atoms increase
  - Increase as the age of atoms increase
  - Is independent of the age
  - Depends on the nature of activity
11. A radioactive material has an initial amount 32 g. After 60 days it reduces to 2 g, then the half-life of radioactive material is:
- 8 days
  - 60 days
  - 30 days
  - 15 days
12. The half-life of radium is about 1600 years. If 100 g radium existing now, 25 g will remain undecayed after:
- 4800 years
  - 6400 years
  - 640 years
  - 3200 years
13. Radio isotopes A & B have half lives of 10 days and 15 days after 1 month. What is the ratio number of atoms undecay A to B:
- 1:2
  - 2:1
  - 3:1
  - 7:6
14. Starting with a sample of pure  ${}^{66}\text{Cu}$ ,  $\frac{7}{8}$  of it decays into Zn in 15 minutes the corresponding half life is:
- 10 min
  - 15 min
  - 5 min
  - 7 1/2 min
15. The number of protons in a nucleus is called:
- Charge number
  - Nucleon number
  - Mass number
  - Neutron number
16. Among the radioactivity radiations, which radiation can blacken the photographic film?
- $\alpha$ -particle
  - $\beta$ -particle
  - $\gamma$ -ray
  - All of these
17. In given nuclear reaction  $\alpha$  and  $\beta$  particles emitted in radioactive decay of  ${}^{200}_{90}\text{X} \rightarrow {}^{168}_{80}\text{Y}$  are respectively:
- 6 and 8
  - 8 and 8
  - 8 and 6
  - 6 and 6
18. Genetic effect of radiation is radiation damage to:
- Any cell except productive cells
  - Any cell including productive cells
  - Only reproductive cells
  - Only lungs cells
19. How much energy is absorbed by a man of 100 kg who receives a lethal whole body equivalent dose of 500 rem in form of low energy neutrons for which RBE is 10?
- 32 J
  - 44 J
  - 50 J
  - 75 J
20. Radioactive iodine-131 is used to combat cancer of:
- Thyroid gland
  - Skin
  - Blood
  - Liver

Sr.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans:	a	a	b	c	c	d	d	a	c	a	d	c	c	c	a

21. Radioactivity is a \_\_\_\_\_.
- Spontaneous Phenomena
  - Nuclear Phenomena
  - Stochastic / Random Phenomena
- (a) i & ii (b) iii & i (c) ii & iii (d) i, ii & iii
22. The half life of radon gas is:
- (a) 23.5 min (b) 3.8 days (c) 4500 years (d) 1620 years
23. 280 days old radioactive sample has activity 6000 dps (disintegration per second). After 140 days activity decreases to 3000 dps. The initial activity in dps was:
- (a) 24000 (b) 12000 (c) 16000 (d) 9000
24.  $\alpha$ ,  $\beta$  and  $\gamma$  rays emitted by a radioactive substance are passed through a region containing a magnetic field at right angles to their path. The energy gained will be:
- Maximum for  $\alpha$ -rays
  - Maximum for  $\gamma$ -rays
  - Minimum for  $\beta$ -rays
  - Zero for all of them
25. A 75 kg person receives a whole body radiation dose of 24 m-rad, delivered by  $\alpha$ -particles for which RBE factor is 12. The equivalent dose in rem is:
- (a) 0.29 (b) 0.97 (c) 0.50 (d) 0.65
26. How much energy is absorbed by a man of mass 80 kg who receives a lethal whole body equivalent dose of 400 rem in the form of low energy neutrons for which RBE factor is 10?
- (a) 32 J (b) 54 J (c) 40 J (d) 48 J
27. The damage from  $\alpha$ -particles is \_\_\_\_\_ unless the source \_\_\_\_\_.
- Large, enters the body
  - Small, enters the legs
  - Small, enters the body
  - Large, enters the arms
28. If RBE factor = 10,  $D_e = 400$  rem, absorbed dose  $D = ?$
- (a) 0.2 Gy (b) 0.04 Gy (c) 0.02 Gy (d) 0.4 Gy
29. The activity of a radioactive isotope decreases from 8000 to 1000 in 60 years. The half life of isotope will be
- (a) 10 year (b) 20 years (c) 30 years (d) 40 years
30. Find the probability that the nucleus of  $^{221}_{87}\text{Ra}$  undergoes decay after three half-lives, if it's a radioactive substance which has a half-life of 6 days.
- (a)  $1/6$  (b)  $3/2$  (c)  $7/8$  (d)  $1/2$
31. The electron emitted in  $\beta$  - radiation originates from where?
- Inner orbits of atom
  - Free electrons existing in nuclei
  - The decay of a neutron in a nuclei
  - Photon escaping from a nuclei
32. Which rays need medium to travel
- X-rays
  - Beta rays
  - Gamma rays
  - No radiation need medium to travel
33. Which rays cannot be produced by electronic transitions?
- Alpha
  - Beta
  - Gamma
  - All of these
34. Average life in terms of decay constant is:
- (a)  $1/\lambda$  (b)  $\lambda^2$  (c)  $2\lambda$  (d)  $2/\lambda$
35. A Uranium isotope  $^{232}_{92}\text{U}$  undergoes one  $\alpha$ -decay and one  $^0_{-1}\beta$ -decay. What is the final atomic number?
- (a) 90 (b) 92 (c) 89 (d) 91

Sr.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
Ans:	d	b	a	d	a	a	c	d	b	c	c	d	d	a	d

## 36. Emission of radiation from radioactive substance is:

- Dependent on both temperature and pressure
- Independent of temperature but dependent on pressure
- Independent for both temperature and pressure
- Independent of pressure but dependent on temperature

## 37. Which one of the following isotopes of Iodine is used for the treatment of thyroid cancer?

- (a) I-113 (b) I-120 (c) I-131 (d) I-140

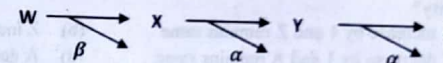
38. A beta ( $\beta$ ) particle is a fast-moving electron. During a  $\beta$  - decay how the atomic number and mass number of a nucleus change?

	Atomic Number	Mass Number
A)	Remains the same	Increase by one
B)	Increase by one	Decreases by two
C)	Increases by one	Remains the same
D)	Decreases by two	Decreases by four

## 39. A naturally occurring radioactive element decays two alpha particles. Which one of the following represents status of daughter element with respect to mass number 'A' and charge number 'Z'?

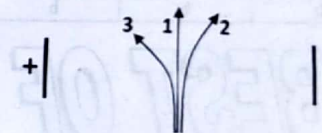
- 'Z' decreases by 4 and 'A' decrease by 2
- 'Z' decrease by 2 and 'A' decreases by 4
- 'Z' decreases by 4 and 'A' decreases by 8
- 'Z' decreases by 8 and 'A' decreases by 4

## 40. A radioactive isotope 'W' decays to 'X' which decays to 'Y' and 'Y' decays to 'Z' as represented by the figure below:



What is the change in the atomic number from 'W' to 'Z'?

- Increased by 3
  - Increases by 5
  - Decreases by 3
  - Decreases by 5
41. Three paths of radioactive radiations are observed as shown in the figure in the presence of electric field. Which type of radiation is shown in path 1?



- Alpha
- Beta
- Gamma
- Cathode rays

## 42. What is the absorbed dose 'D' of a sample of 2 kg which is given an amount of 100 J of radioactive energy?

- (a) 200 Gy (b) 102 Gy (c) 50 Gy (d) 98 Gy

43. In the reaction,  $^{234}_{92}\text{Th} \rightarrow ^{234}_{91}\text{Y} + ^0_{-1}\text{e}$  the electron  $^0_{-1}\text{e}$  emits from the:

- 1<sup>st</sup> orbit
- 2<sup>nd</sup> orbit
- Nucleus
- Valence Shell

44. According to the equation  $^A_Z\text{X} \rightarrow ^A_Z\text{Y} + 3\alpha$  particles, what are the atomic and mass number of 'Y'?

- $Z-6, A-12$
- $Z-2, A-4$
- $Z+1, A$
- $Z+3, A$

## 45. Cobalt 60 is used in medicine and is an intense source of:

- $\alpha$ -particle
- $\beta$ -particle
- $\gamma$ -rays
- Neutrons

Sr.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.
Ans:	c	c	c	c	c	c	c	c	a	c

46. Sodium 24 has half-life of 15 hour and it is used in medicine to estimate:

- (a) Kidney Function (b) Plasma Blood Volume  
(c) Iron in Plasma (d) Thyroid Function

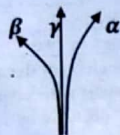
47. Wavelength of  $\gamma$ -rays is:

- (a) Equal to the X-rays (b) Shorter to the X-rays  
(c) Longer to the X-rays (d) Boarder to the X-rays

48. Which of the following is unit of absorbed dose?

- (a) Sievert (b) Gray (c) Roentgen (d) Curie

49. In a radioactive phenomenon observation shown in figure where  $\alpha$  deviates lesser than  $\beta$  in some electric or magnetic field (not shown in figure). What is the reason of less deviation of  $\alpha$ ?



- (a)  $\alpha$  is charged particle (b)  $\alpha$  is neutral particle  
(c)  $\alpha$  is heavier particle (d)  $\alpha$  is lighter particle

50. Which of the following effect is observed due to emission of  $\beta$ -during the phenomenon of radioactivity?

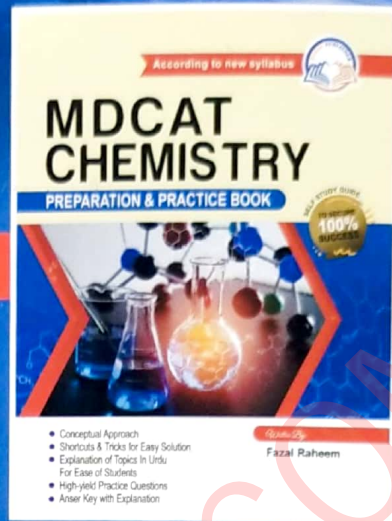
- (a) A increase by 1 and Z remains same (b) Z increase by 1 and A remains same  
(c) Z decrease by 1 and A remains same (d) A decrease by 1 and Z remains same

Sr.	46.	47.	48.	49.	50.
Ans:	b	b	b	c	b

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